Volume Index for 1933, Page 637

DEC

Heating · Piping and Air Conditioning

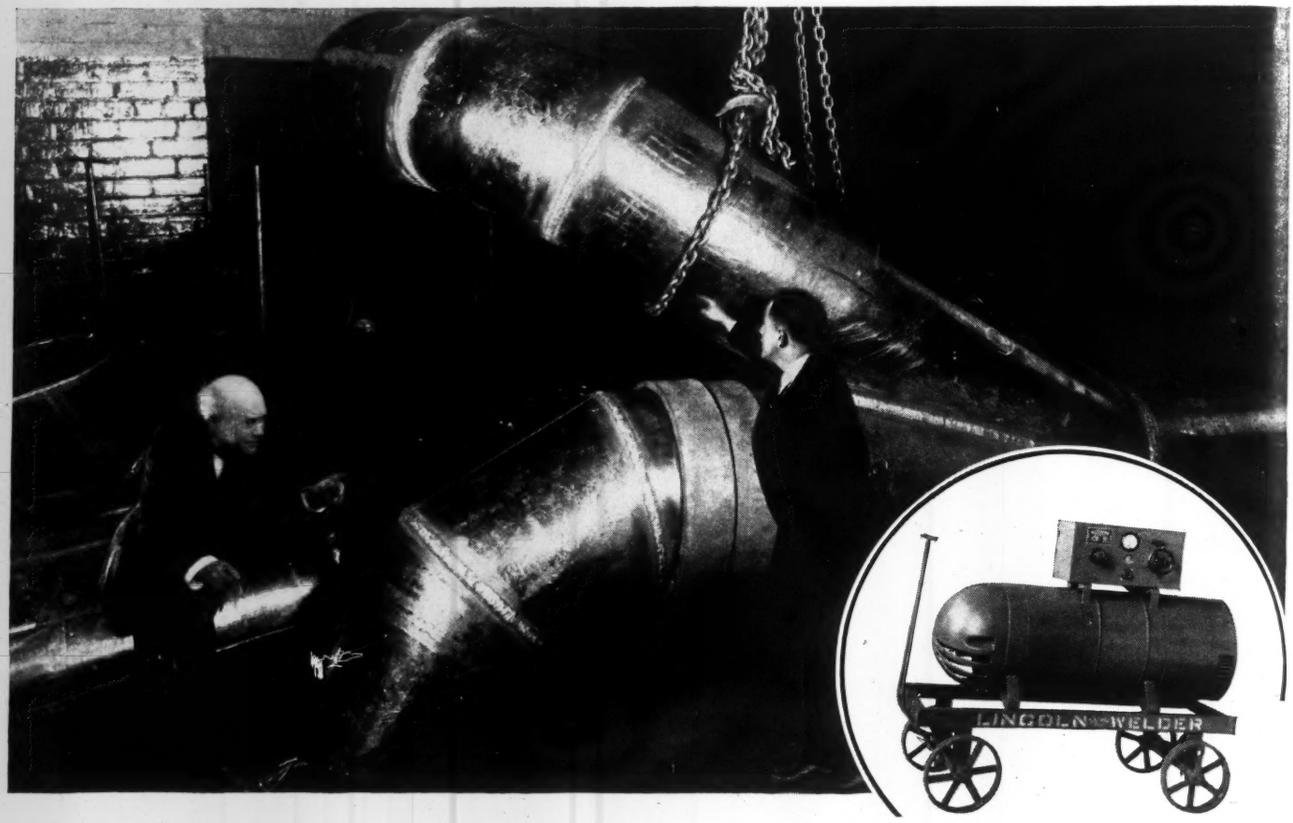
Industrial Fan Drives Offer Power-Saving Possibilities

Piping Materials Specifications .....High Temperature Piping

and many others, including....
Method of Cleaning Radiators. Partly-Air-Conditioned Building. Brewery-Cellar Piping. *Also, the*

Journal Section of the A.S.H.V.E.

POP AND LAD TALK OVER Y'S AND WELDING . . .



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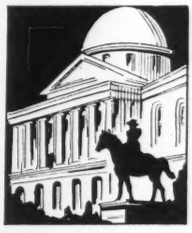
THE EDITOR'S PAGE

PUBLIC WORKS MODERNIZATION



THE plan for expending a portion of the PWA fund for modernizing mechanical equipment in existing public buildings, given so much attention in the last three issues of this publication, has been pushed hard enough to make the administration at least give it thought. The PWA, in fact, has made numerous small loans of this class.

From reports, however, we judge that PWA officials fear to give this plan too much approval lest they be swamped with an avalanche of applications for loans that will slow down supposedly more important public works. Modernization of mechanical equipment, when it represents substantial capital investment, is eligible for consideration. But Washington expects to do more for mechanical equipment through the thorough equipping of new buildings than through the modernization of old.

This smacks of too much prosperity—can't be bothered with a few thousand dollars when there are billions at hand. Nevertheless, we would say it is progress, for it does show that an application for a modernization loan will be given consideration, and the larger the project, the greater the consideration. Under such circumstances, we say, let the applications fly.

THERE is no good reason why this industry should not be given consideration in a government activity which is primarily aimed to restore purchasing power through increased employment. Members of this industry have been hit harder than most, and the modernization recommendation is so sound from an economic and engineering view-point that we see no reasonable logic in turning it down because many individual projects might be small. Many are large, too, and the total of them all could run into the hundreds of millions if PWA would establish this kind of work as a definite division of its program. Furthermore, they are projects which need not be held off during the winter months—not true of many forms of new construction.

WE BELIEVE, therefore, that everyone connected with the field of mechanical equipment should keep right after this idea of getting part of this PWA money for modernizing existing buildings. As we have said before, the need is to survey public properties, get all the facts, and submit definite projects for loans. We think that PWA should retain competent consulting engineers for this purpose. Whether it will or not, however, does not prevent the individual engineer, contractor, or manufacturer from lining up such projects on his own initiative.

COMING

Future articles in Sabin Crocker's series on piping standardization (the fourth installment of which is published this month) will discuss the A.S.A. Proposed Tentative Code for Pressure Piping, which will be released shortly for criticism by industry. The history and purpose of the Code will be explained and important sections abstracted and reviewed. . . . . Don't miss these valuable articles!

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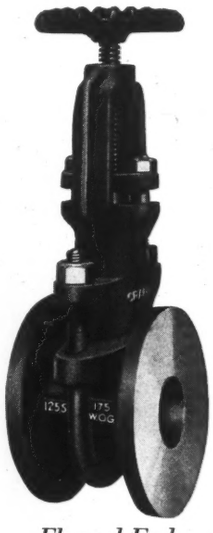

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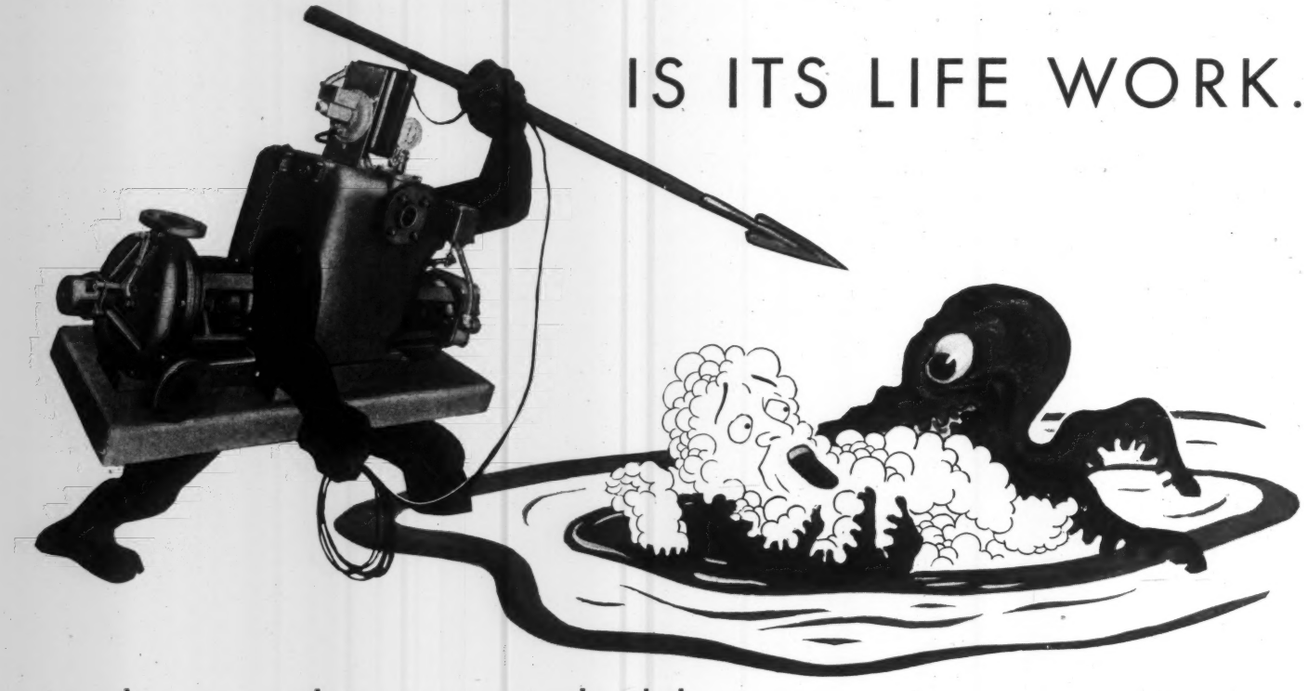

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Heating · Piping and Air Conditioning

December, 1933

Industrial Fan Drives *offer* Power-Saving Possibilities

By Robert W. Drake*

There are many able plant engineers and operating engineers to whom it is an entirely new idea that 1/8 to 7/8 of the power consumed by half of the fans in their charge can be saved during part or all of each year without lowering appreciably the quality of the service. In these days, with factors in competitive cost fixed in large measure by codes, such savings are particularly welcome to industry.

The author outlines here (in simple and practical manner) the advantages to be gained by occasional changes in fan speed. In most applications, a painstaking day-to-day or hour-to-hour adjustment of fan speed is not necessary to obtain the greater part of the possible savings. To accomplish the greater part of the savings possible in many applications requires change in fan speed at intervals varying from three months to as many years.

The author of this article has had many years experience as a plant operating engineer, has actually accomplished power savings of this kind in his own systems.

ECONOMY in the application of driving power is of more importance in pump and fan installations in the ventilating and air-conditioning field than in most cases of motor drives. There are two reasons for this:

In most installations, fans and pumps run continuously at full load for all working hours of the year, frequently for many non-working hours also. The resulting power consumption is, therefore, much greater per motor horsepower installed, than is the case with ordinary industrial equipment which operates under a variable load, in many cases with some idle periods.

The power consumption and performance of centrifugal fans is exceedingly sensitive to variations in speed. For example, let us say that a fan is delivering (or exhausting) 10 per cent more air than is really needed for satisfactory performance of its function. This seems a trifling excess; many designers provide much more excess volume than this "to be safe." However, if we slow down the fan 10 per cent, its delivery will be reduced only by the allowable 10 per cent, but the power consumption will be reduced nearly 30 per cent. The explanation lies in the fact that, to force 10 per cent more air through the system of ducts and orifices, requires 20 per cent increase in pressure.

Far larger possibilities for power saving are not unusual. Consider a case where fumes and vapor must be collected by a hood located far enough above their source to allow access for adding unprocessed material and removing finished product. In the summer, when windows are open, the natural drafts tend to carry these fumes out from under the hood; when there is considerable wind the suction on the hood must be high for this class of work.

In the winter, with windows closed, the hot fumes rise naturally into the hood, and half the former air removal may suffice. Thus, the fan and exhaust system will give satisfaction in the winter if operated at, say, half the speed necessary in summer. The resulting reduction in power saving will be of the order of 87½ per cent—*i.e., 7/8 of the total power is saved.*

Notwithstanding this, the fan would be run at the same speed the year 'round in nine plants out of ten. At most, the inlet might be choked somewhat by means of a slide gate, which reduces the volume handled, but maintains the full pressure or suction unchanged when handling the decreased volume, thus producing only one-third as great a net saving in power as is possible by fan-speed reductions.

We walk past fan applications every day where an occasional change in speed would (over a period of years) save much power or greatly improve performance.

*Mechanical and Electrical Engineer, DeKalb, Ill.

Why Such Savings Are Possible

The designers' first difficulty is to pre-determine the minimum pressure which will give satisfactory performance in a new system; ordinarily, no precision is possible. The effort must be to provide a pressure sufficient to assure satisfactory performance with some margin for contingencies such as errors in estimating duct resistance, additional outlets after plans are completed, roughening of duct walls over a period of years from deposits of dirt, lint or other foreign matter. It must be admitted

V-belt-driven dust-collecting system fan at Anaconda Copper Mining Co.

that the estimation of duct friction losses is of necessity approximate; a precision comparable with the electrical engineer's computations for resistance drop in conductors or with the water-supply engineer's estimates of friction in pipe is very seldom attainable. A duct system is full of bends, offsets and elbows to avoid obstructions. These fittings can seldom be made to follow any definite standards as to curvature, but owing to the relatively large size of fan piping they must frequently be laid out individually to suit the space available. Occasional changes from round to square and back again are sometimes necessary. Estimates of resistance to flow through such fittings are rough.

Since the designer necessarily makes ample allowance for such contingencies, in the typical job a considerable saving of power could be made at the start and for some years thereafter if suitable means were provided for slowing down the fan without unduly increasing the motor losses. As time goes on, a few additional outlets with consequent increase in delivery and in main duct friction, and gradual roughening of duct walls caused by dirt and lint incrustation, cause less satisfactory performance. Occasionally the user, after a few years' experience with good ventilation, demands that an installation, originally satisfactory to him, be further improved.

It is, of course, advisable to clean the ducts at intervals. If they are large enough to pass a man considerable can be accomplished in this way, but no ordinary cleaning methods have a great deal of effect on the smaller branch piping where most of the resistance is, particularly if it is rectangular.

Most practical method for returning the system to its initial satisfactory performance is a slight increase in fan pressure. In many cases, particularly in industrial installations, an increase of 5 per cent in speed every two or five years is required to offset the gradual roughening of the duct surface due to the deposit of lint and dirt, oil vapors or dust, particularly in the small branch piping.

In some cases a worth-while saving may be realized by decreasing the fan pressure (or suction) during the slack season when part of the outlets are closed and the friction in the main piping thereby reduced. In other cases it seems advisable to plan the original installation with reserve capacity to care for possible increased demand due to additional future outlets, increased future duct resistance caused by roughening of duct surfaces from the adhesional foreign matter, dirt or lint. In such cases the maximum fan pressure or suction may not be required for years, if ever. Small increases every year or two are needed to keep the system performance at the desired level.

In still other cases reserve fan capacity may seem advisable when the system is being designed because the purpose of the installation is new, very little data from previous installations are available and the required volumes can therefore be estimated only very roughly.

Similarly, in industrial installations reserve capacity may be installed because it is suspected that as the men gain skill and as improvements in mechanical equipment are made, the process output may be greatly increased with the result that fumes, dust, etc., will be produced at a greatly increased rate and more frequent air changes be advisable.

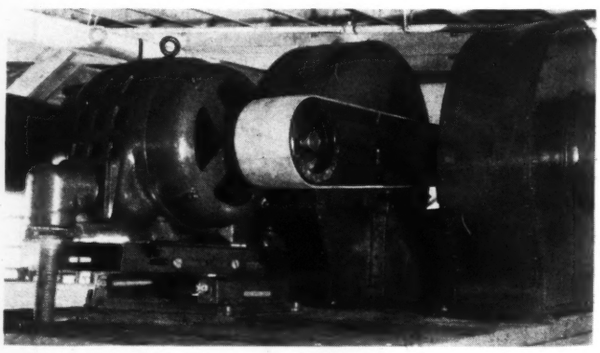
It is evident that there are at hand many unsuspected opportunities for power saving by speed control of fans. There remains the question of the proper method for accomplishing the required changes in speed.

How the Savings May Be Obtained

Variation of Motor Speed

There are a number of possible means for varying the fan pressure or suction. The most suitable means depends largely upon the frequency of variation required. When most economical operation demands a cyclic change of pressure hour by hour or day by day, the most adaptable means available is variation in the speed of the driving motor. Where direct current is available, this is easy. Variable speed motors of several types are available, including slow-speed motors designed especially for driving large fans and capable of 20 per cent or more variation in running speed.

For alternating current, there are several types of variable-speed motors available. Single- and three-phase



Flat belt drive (motor on special base) for exhaust system in a woodworking shop

brush-shifting motors are well suited to some applications. Their principal disadvantages as compared with the more familiar induction motors are increased first cost, somewhat lower reliability and increased maintenance expense and perhaps most important, the fact that the principles of their performance and construction are less generally understood by the average maintenance and repair men.

For installations where it appears wise to sacrifice some power saving, the well-known slip-ring induction motor is well suited. Such motors realize roughly two-thirds of the possible saving in power available through operation at speeds below the maximum speed of which the installation is capable. Particularly in cases where full-speed operation is the rule and reduced speed operation is possible for only half the time or less, these motors may well be chosen. Considering their advantage in first cost as compared with brush-shifting motors, they may well result in equal or better over-all dollar efficiency in an installation where reduced speed operation is possible for only a few hundred hours per year.

Throttling the Flow

As mentioned briefly earlier in this article reduction in delivered volume by throttling the flow, as with a slide gate, a device still commonly met with, realizes only one-third the possible power saving. This results from the fact that the reduction in volume and velocity is accomplished without any gain from simultaneous reduction in fan pressure or suction. The remaining two-thirds of the possible saving is wasted in pressure loss through the throttlng orifice.

Special Fan Runner

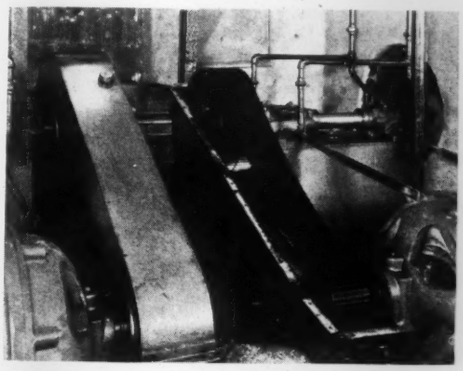
Speaking broadly there are two methods which most often prove desirable for handling the cases where pressure changes are needed only at long intervals.

Where the fans are direct connected, a special fan runner of diameter somewhat below standard diameter may be installed during periods when reduced pressure is sufficient. Similarly a slightly over-size runner may be installed if a slight increase in pressure is desired. This latter expedient cannot be carried far for two reasons. First, runner diameter cannot be increased more than 5 per cent, or at the most 10 per cent, without a decided loss in fan efficiency. There is not sufficient room in the scroll casing outside the enlarged runner to handle the increased air volume without producing a decided reduction of velocity as the outlet is reached with consequent loss of velocity head within the fan. Second, if no decrease is to be made in the area of the outlets or inlets, a 5-per cent increase in runner diameter will increase the pressure (or suction) 10 per cent and increase the power consumption 15 per cent; a 10-per cent increase in runner diameter will increase the pressure 21 per cent and the power consumption 33 per cent. Thus, unless the motor runs fairly cool in the first place, it is seldom possible to increase the runner diameter more than 5, or at most 10, per cent on a direct-connected fan without installing a larger motor.

A decrease in runner diameter of 20 per cent will decrease the volume delivery by 20 per cent, decrease the pressure 36 per cent, and decrease the power consumed by almost 50 per cent. In a 30-hp fan installation in which a 20-per cent volume reduction will give satisfactory performance for, say, 1500 hours per year (the dull season, the winter season, or what not) the resulting saving in the power bill will be $200 to $500, depending upon the power cost and whether the dull season for this fan occurs when the other power load is light or at a maximum.

Too often, the man in authority does not realize that he will save as much as this, and hesitates to make the expenditure required for the required runner. Then, too, it frequently takes several hours to make the change.

When constant-speed, a-c, squirrel-cage motors direct-connected to fans are already installed, special runners generally offer the only practicable method of pressure variation. Occasionally it may prove best to purchase



Two 60-hp silent-chain drives operating fans

a slip-ring rotor, one new end shield and a speed controller for the motor; such a change involves no special equipment for motor manufacturers regularly employ the same stators and stator windings for both squirrel-cage and slip-ring motors of the same rating.

This expedient often costs but little more than a special runner, particularly in the case of fans for low pressures. It has the advantage that a speed change thereafter only requires the turn of a controller handle. It is best to furnish mechanical means for blocking the controller at the desired speed point in order that no unauthorized person may change the speed under the impression that the faster things go the better.

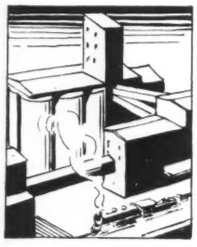
The disadvantage of this expedient is, of course, the fact that of the possible saving, one-third is lost in the grids of the speed controller, leaving a net saving of only $125 to $325 to continue the example quoted above. Two-thirds actually saved, however, is much superior to three-thirds which could be saved, but isn't.

Changing Drive Pulleys, Sheaves, or Sprockets

For new installations, or old installations where the fans are not direct-connected, the most generally useful expedient for varying fan speeds at intervals of months or years is a change in the diameter of the driving pulley, driving sheave or driving sprocket as the case may be. A pulley, sheave, or sprocket is relatively inexpensive, only 15 or 20 minutes are required to make the change, the spare or spares may be fastened up on the wall of the fan room or on an adjacent column by means of a lag screw or a bolt so that storage or a mix-up among a number of spares is not a problem. No one minds changing a pulley once or twice a year.

[In his next article, Mr. Drake will consider the selection and applications of the various types of drives—such as V-belt, flat belt, chain, etc., describing their respective fields of application, discussing their advantages and their limitations.—EDITOR.]

Design Temperatures . . . for Heating Plants . . . . Based on a Fixed Overload



By **L. C. Price***

THERE seems to be no hard and fast rule for the establishment of design temperatures for heating plants in different parts of the country. The *Guide* of the *American Society of Heating and Ventilating Engineers* says that the design temperature must not be more than 15 degrees Fahrenheit above the lowest temperature recorded during the preceding ten years. That rule still leaves a 15-degree range for the exercise of individual judgment in any given locality. In severe climates the 15-degree limit is on the side of safety, but in very mild climates the differential between the design temperature and the *LRT* (lowest recorded temperature) must be less than 15 degrees to avoid heavy overloading of the heating plants in the coldest weather.

Consider for instance the two extremes of New Orleans, Louisiana, and Havre, Montana. The *LRT* in New Orleans is 7 degrees above zero. Strict adherence to the 15-degree limit would place the design temperature there at 22 degrees. On a day when the outdoor temperature dropped to 7 degrees, the load on a New Orleans heating plant would be $\frac{70-7}{70-22} \times 100$, or 131 per cent of rating, if the indoor temperature were kept at 70 degrees. It is doubtful if many plants can be driven at that rate, after a few months' use. In Havre, Montana, the *LRT* is —57 degrees, which, by the 15-degree rule, calls for a design temperature of —42. In the most severe weather, therefore, the rate of operation in Havre would be $\frac{70+57}{70+42} \times 100$, or 113.4 per cent of rating.

Use Fixed Percentage of Overload

Suppose that instead of basing the design temperature on a constant variation from the *LRT*, we determine it according to some fixed percentage of overload on the heating plant. It may reasonably be expected that a heating plant will carry a 20-per cent overload for short periods of time. On this basis, the design temperature in New Orleans would be $\frac{7+14}{1.2}$, or 17.5 degrees, and that in Havre would be —36 degrees.

Also to be considered is the amount of discomfort which would result from failure of the heating plant to carry the required overload. Suppose that the outdoor temperatures in New Orleans and Havre drop to 7 degrees and —57 degrees respectively, and that neither heating plant will carry an overload greater than 10 per cent; consider first, heating plants designed for a temperature 15 degrees above the *LRT* in each case. With a 22-degree design temperature and a 10-per cent overload, the New Orleans plant will maintain an indoor temperature of only 60 degrees, while, with a —42-degree design temperature and the same overload, the Havre plant will keep the indoor temperature at 66 degrees. On the other hand, if both designs are based on a 20-per cent overload and the plants can carry only 10 per cent, the inside temperature in New Orleans will be 65 degrees, while that in Havre will be only 60 degrees. All these figures are based on a direct proportionality between load and temperature difference between indoors and outdoors.

Consideration of the above results leads to the conclusion that some modification of the 15-degree rule is necessary to assure comfortable indoor temperatures in all climates in the most severe weather. It is proposed, therefore, to design for operation at 120 per cent of rating in the most severe weather *provided* the design temperature thus determined is not more than 15 degrees above the lowest recorded temperature; otherwise, to make the design temperature 15 degrees above the *LRT*. This would give New Orleans a design temperature of 17.5 degrees, which closely agrees with practice there, while the design temperature in Havre would remain unchanged at —42 degrees. A few other examples of lowest recorded temperatures, and heating plant design temperatures determined in this way are:

Little Rock, Ark., —12 degrees and +2 degrees; Fort Smith, Ark., —15 and —1; Fayetteville, Ark., —24 and —9; Kansas City, Mo., —22 and —7; Lincoln, Neb., —29 and —14; Ithaca, N. Y., —22 and —7. There is an extremely close agreement between these design temperatures and the ones actually used in the places named.

*Research Engineer, Engineering Experiment Station, University of Arkansas, Fayetteville.

NEITHER dimensional standards nor materials specifications would be sufficient independently, since the adequacy of either depends on what is used for the other.....Dimensional standards were covered in the first two articles of this series; this month, as last month, materials specifications is the subject

Piping Standardization.....

Materials Specifications

By **Sabin Crocker***

THE specifications for piping materials of the *American Society for Testing Materials* embrace a wider variety of products and are in more general use than those of any other specification-writing body; the specifications of the *A.S.T.M.* were therefore classified and interpreted in the article on piping standardization last month. This month the materials specifications of other bodies are listed and discussed. In addition, pipe for fusion welding and piping materials for high-temperature service are considered.

National Piping Specifications Other Than A. S. T. M.

There are a number of piping specifications of national scope prepared by organizations other than the *American Society for Testing Materials.* Among the principal groups which have drafted such specifications are: *The American Water Works Association, The American Petroleum Institute, The American Gas Association,* and the *U. S. Steamboat Inspection Service, U. S. Army, U. S. Navy,* and the *Federal Specifications Board.* In most cases these specifications cover both dimensional standards and material requirements, including tests. In some instances these specifications exist because there is as yet no *A.S.T.M.* Specification for the article in question; in other cases the group concerned believed it needed special requirements other than those which were acceptable to industry in general as embodied in the *A.S.T.M.* version. Several such commonly-used specifications are:

A.W.W.A. Standard Specifications for Cast-Iron Water Pipe and Fittings, Adopted May 12, 1908. Standard dimensions and weights for hub-and-spigot pipe and fittings; method of manufacture; marking; physical properties and tests; hydrostatic tests; permissible variations; coating. Eight weights of pipe are provided and several weights of fittings. This specification applies to pipe which is cast vertically in 12 ft lengths in dry-sand molds. The product is similar to that covered by *A.S.T.M. Specification A44-04,* the principal difference being in that the *A.W.W.A.* specification contains more extensive dimensional standards.

Federal Specifications Board Specification for Cast-Iron Bell and Spigot Water Pipe, July 21, 1931. This specification covers two classes of pipe for 150- and 250-lb maximum water working pressure, each class consisting of the three following types; *Type I,* Centrifugally cast in metal contact molds in 12 and 18 ft lengths; *Type II,* Centrifugally cast in sand-lined molds in 16, 16½, and 20 ft lengths; *Type III,* Horizontally cast in green sand molds, in 12 and 16 ft lengths. Requirements for cement lining are provided for when desired. Like the *A.S.T.M.* and *A.W.W.A.* specifications for hub-and-spigot water pipe, this specification covers: Dimensions and weights; method of manufacture; marking; physical properties and tests; hydrostatic tests; permissible variations; coating; etc., but the requirements differ in many ways to suit the nature of the product.

A.G.A. Standard Specifications for Cast-Iron (Gas) Pipe and Fittings, Adopted 1913. Includes both bell-and-spigot, and flanged cast-iron pipe and fittings for gas. The scope of this specification is similar to that of the *A.W.W.A.* specification listed above, except that the product is intended for low-pressure gas and confined to a light weight of material.

A.P.I. Specifications for Line Pipe, A.P.I. Standard No. 5-L. Manufacture; chemical composition; physical properties and tests; hydrostatic tests; standard dimensions; weights, and lengths for pipe and couplings; permissible variations; standards for thread dimensions and gaging; marking. The scope includes: In the furnace-welded product wrought-iron pipe, open-hearth-iron pipe, one grade of bessemer-steel, and two of open-hearth; and in seamless, three grades of open-hearth or electric steel. These specifications differ from those of the *A.S.T.M.* for pipe principally in that more kinds are grouped together in one specification, and a longer thread is required.

Pipe for Fusion Welding

The recent widespread adoption of fusion-welded pipe joints has been the occasion for much discussion of preferred chemical composition of pipe material, of the necessity for clean metal free from slag inclusions and laminations, and closer dimensional tolerances. In general a mild-steel pipe having a carbon content of not to exceed 0.35 per cent is considered the most readily weldable, although alloy-steel pipe and carbon-steel having a carbon content above 0.35 per cent have been suc-

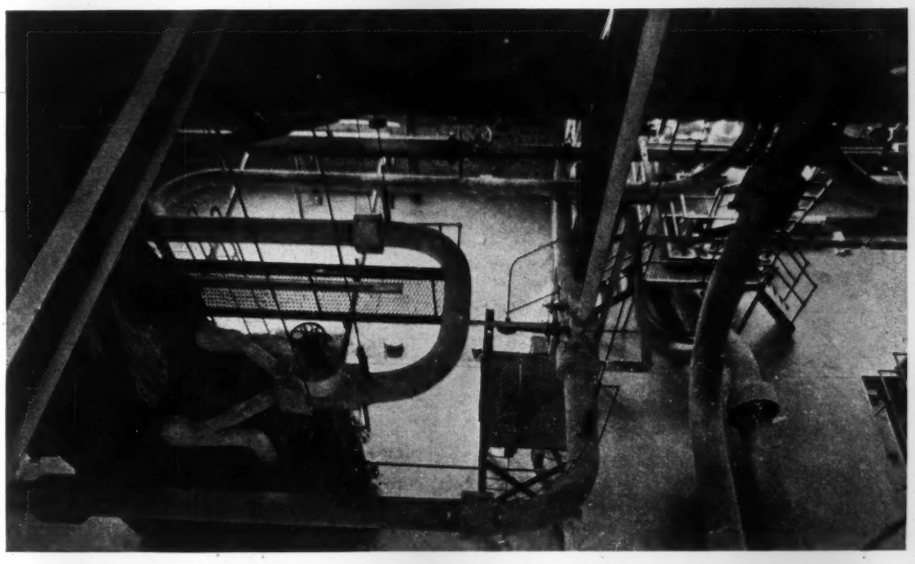
*Engineer, The Detroit Edison Company, and Member of Board of Consulting and Contributing Editors. Mr. Crocker is Secretary, *A.S.A.* Sectional Committee *B36* on Standardization of Wrought Iron and Wrought Steel Pipe and Tubing, and of Subcommittee *XXII* of *A.S.T.M.* Committee *A1,* which is responsible for the preparation of piping specifications for high-temperature service. He also is a member of *A.S.A.* Sectional Committee *B16* on Pipe Flanges and Fittings, and of Sectional Committee *B31* on Code for Pressure Piping.

This is the fourth article of a series on the status of national standardization of piping, and is the second to be devoted to materials specifications.

Table 1—Typical Properties of Several Alloy-Steel Piping Materials Suitable for Operating Temperatures Above 750 F.

Type of Steel	Carbon	Manganese	Silicon	Molybdenum	Nickel	Chromium	Tungsten	Vanadium	Sulphur	Phosphorous		Temperature F	Tensile Strength 1000 psi	Yield Strength 1000 psi	Elongation in 2 In. %	Reduction of Area %	Impact Resistance Ft-Lb	Condition of Creep Specimen	Stress for Creep Rate 1% in 100,000 Hrs, psi
Temperature Range 750F to 1000F—Pearlitic Steels																			
Bolting																			
Chrome-Tungsten-Vanadium	0.40–0.50	0.20–0.35				1.2–1.4	1.75–2.25	0.20–0.30				75	180–190	150–160	11–15	35–45			
												750							40,000
												850						Note 2	28,000
												950							12,000
												1000							7,000
Chrome-Tungsten	0.35–0.45	0.80–0.95				0.45–0.60	0.80–1.00					75	130–145	110–135	16–22	55–62			
												750	124						
												850	115						
												950	105						
												1000	100						
Nickel-Chromium	0.25–0.35	0.50–0.80			1.0–1.50	0.45–0.75			0.045	0.040		75	115–140	90–125	22–26	64–67			
												750							
												850							
												950							
												1000							
Castings																			
Chrome-Nickel-Molybdenum	0.20–0.30	0.40–0.80	0.25–0.30	0.30–0.50	1.00–1.25	0.50–0.75			0.05	0.050		75	85–115	65–80	18–20	35–45	Izod 25-30		
												750							
												850							
												950							
												1000							
4-6 Chromium with Molybdenum	0.15–0.35	0.45–0.85	0.20–0.60	0.40–0.65		4–6			0.05	0.05		75	80–110	55–75	18–22	30–40			
												750							
												850							
												950							
												1000						Note 3	7,000 to 10,000
Forgings																			
Nickel-Chromium	0.35–0.45	0.30–0.60			1.50–2.0	0.90–1.25			0.04	0.04		75	120–150	105–135	19–22	56–64			
												750							
												850							
												950							
												1000							
Manganese-Molybdenum	0.10–0.15	1.0–2.0	0.15–0.30	0.20–0.50								75	85–90	75–80	25–30	65–75	Izod 95–105		
												750							
												850						Note 3	30,000
												950							20,000
												1000							10,000
																			6,000
Pipe																			
Carbon Steel	0.25–0.35	0.80	0.15						0.05	0.05		75	65–75	40–50	30–40	65–75	Charpy 34–36		
												750							
												850					17–20		11,000
												950							5,500
												1000							3,500
Manganese-Molybdenum	0.10–0.15	1.00–2.00	0.15–0.30	0.20–0.50								75	85–90	75–80	25–30	65–75	Izod 95–105		
												750							
												850						Note 3	30,000
												950							20,000
												1000							10,000
															19–25	72–85			6,000
Temperature Range 950 F to 1100 F—Austenitic Steels																			
Bolting, Castings, Forgings and Pipe																			
18–8	0.06–0.15				8–10	18–20			0.05	0.05	Titanium Note 1	75	85–90	38–40	55–60	60–70			
												750							
												850							
												950							15,000
												1050	70–75	20–25	40–45	70–75		Note 4	10,000
												1150							6,500
												1200							5,500

[1]Titanium six times carbon content in excess of 0.02%. [2]Quenched 1650 F, drawn 1200 F. [3]Normalized, and drawn at 1200 F. [4]Quenched from 1900 F.
Note: "Psi" = "lb per sq in."



Experimental 1100-F superheater and piping at the Trenton Channel Plant of The Detroit Edison Company; this small installation was made to obtain information on the behavior of the superheater and the pipe line at this extremely high temperature

cessfully welded by the fusion process. A committee of the *A.S.T.M.* has studied the weldability of various steels and submitted a list of *A.S.T.M.* specifications for steel plates, structural members, and pipe which it recommends for use where welded construction is employed. The following is quoted from the published report of this committee, which bears the *A.S.T.M. Designation A151-33.*

"While lower carbon steels are naturally easier to weld, other factors being equal, steels up to 0.35 per cent carbon have been welded with satisfactory results under the usual commercial practice. Other steels can be fusion welded satisfactorily when suitable fluxes and filler metal are used and proper working conditions are observed.

"The committee considers that steel made under any of the conditions listed can be fusion welded satisfactorily. Normally, steel made under any of these specifications will run under 0.35 per cent carbon. When special limits are required they should be specified by the purchaser."

Piping Materials for Service at Temperatures Up to 1100 F

For several years the trend in power plants and oil refineries has been toward higher pressures and temperatures. High pressure alone does not constitute a particularly difficult problem in piping design, since thicker parts or stronger materials are readily applied. Operation at temperatures above 750 F, however, introduces a number of complications which involve: Plastic flow or creep of materials; an increased tendency toward scaling and other manifestations of corrosion, especially at temperatures approaching 1000 F; and, in some steels, a tendency toward an unfavorable change in the metal structure due to prolonged exposure to high temperature while under load.

Due to the combination of these factors it is generally conceded that the use of carbon-steel piping materials should be confined, for long-life equipment at least, to temperatures below 1000 F. The *A.S.M.E.* Boiler Code Committee has set up a schedule of allowable stresses at 50-F temperature increments for carbon-steels up to a maximum temperature of 950 F. As explained in a previous installment of this series of articles,[1] subcommittees of the *A.S.A.* and *A.S.T.M.* acting jointly have worked out a schedule of adjusted ratings for carbon-steel pipe and fittings at a series of temperatures up to 850 F, with provision for the use of higher temperatures at the discretion of the designing engineer.

A further need was sensed for standard specifications to establish safe working stresses for alloy steels suitable for use at temperatures up to at least 1100 F. Subcommittee *XXII* of *A.S.T.M.* Committee *A1* has been studying for some time the drafting of specifications for alloy-steel piping materials suitable for operating temperatures of 750 to 1100 F. The present thought is to have separate specifications for alloy-steel bolts, castings, forgings, and pipe paralleling the set-up of the carbon-steel specifications for these articles. Allowable stresses would be set for a series of temperatures with reference to the creep strength of definite materials at these temperatures. This program has been waiting for some time on the development of standard methods of procedure for conducting and reporting creep tests by the *A.S.M.E.-A.S.T.M.* Joint Committee on the Effect of Temperature on the Properties of Metals. Now that this standard procedure is available, it is hoped that these projects can be put in shape for publication as tentative *A.S.T.M.* specifications, which will make them available for review and criticism by industry in general.

While it is impracticable to attempt to present here a complete review of the alloy steels available for high temperature piping, the partial listing shown in Table 1 will give an idea of the nature of some of the low-alloy steels in use or suggested for this application. The properties listed are typical only; creep values in particular should be regarded as not entirely comparable, since they were reported by different investigators before a standard procedure was established. Some interpolation was necessary with creep and other physical properties to obtain tabular values for a uniform temperature schedule.

For temperatures above 1000 F the corrosion-resistant alloys and austenitic steels containing relatively high

[1] See page 457, September, 1933, Heating, Piping and Air Conditioning.

percentages of chromium and nickel, with or without other alloying elements, have their place. A typical alloy of this type is listed in Table 1.

Bolts

In settling satisfactory working stresses for piping operated at temperatures much in excess of 750 F, consideration must be given to the amount of creep which is permissible for the part in question without impairing its usefulness. If piping is to be taken down frequently for inspection and cleaning, as is the case with some oil-refinery lines, a relatively high rate of plastic flow in bolts and other parts subjected to continuous creep is not objectionable. In this case the bolts will be re-tightened when put back in place, while fittings and flanges which are unduly distorted can be discarded after a few years' service. With power piping intended for long life, say 15 to 20 years or more, it is customary to think in terms of stresses which will not cause creep in excess of one per cent in 100,000 hours, as conventionally reported. Since creep of flange and bolt material reduces the initial stresses and hence the rate of creep, it is necessary to have very complete creep data in order to predict joint life with any certainty. Retightening the bolts periodically will enable a tight joint to be maintained indefinitely with working stresses involving relatively large creep. The alternative method of design is to provide flanges and bolting so heavy for the service intended that working stresses will not be appreciably reduced by tendency to creep.

Pipe

Pipe offers a somewhat different problem than bolts and flanges. In the first place it is subjected to continuous circumferential creep from the load due to bursting pressure, which tends to produce progressive stretching of the material. When designing pipe for long service at high temperatures, the usual practice is to select a wall thickness such that the bursting stress, after proper deductions for corrosion allowance and manufacturing tolerances have been made, will not exceed approximately 2/3 of the stress which creep investigators have found will cause the material to extend at the rate of one per cent in 100,000 hours. This is deemed to provide a sufficient margin for slight variations in the properties of the material, for deterioration in strength due to changes in the metal structure occurring at the operating temperature over a long period of time, and for chance of short periods of exposure to temperatures in excess of that for which the line was designed.

Secondly, the pipe is subjected to bending stresses due to thermal expansion of the line, which are separate and distinct from bursting-pressure stresses. Fortunately it is the longitudinal stress, among those resulting from the constraint of thermal expansion, rather than the transverse stress produced by flattening of the circular cross-section, which has been found related to the failure of curved pipe in bending.[2] In combining stresses due to internal pressure with those produced by bending, the longitudinal stress due to internal pressure is the one which is additive to the longitudinal bending stress. Since the longitudinal stress due to internal pressure is approximately one-half the magnitude of the bursting stress, a considerable margin is available for bending stress between the total allowable stress and the longitudinal pressure stress. Relatively high total longitudinal stress may be permitted at temperatures involving creep, since the bending stresses caused by the constraint of thermal elongation of the piping tend to be relieved by plastic yielding of the line to a shape of lower stress. Where large bending moments occur at bolted joints, the disturbing effect may be such as to require designing for lower total longitudinal stresses in the pipe adjacent to the joints, if they are to be kept pressure-tight for long periods.

While some of the foregoing comments may seem to involve engineering mechanics rather than the specification of materials, due correlation with design principles is essential to a rational selection of the best material for any high-temperature application. It is entirely logical, therefore, that the two be considered together.

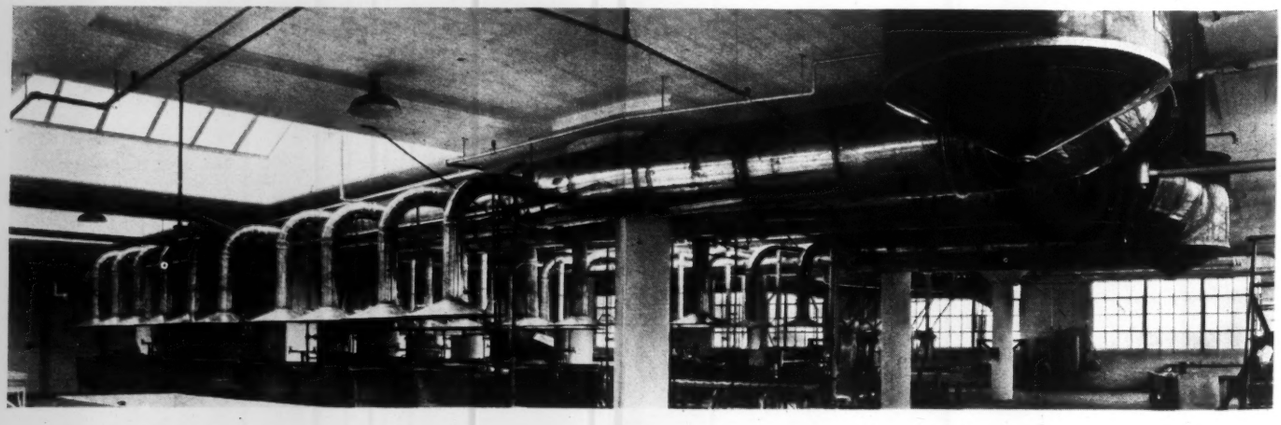
[2]See "Piping Handbook," by Walker and Crocker, 2nd Edition, pages 556-560.

COLLECTING FUMES FROM COOKING KETTLES

At the plant of the Tea Garden Products Co., Seattle, Wash., this all-copper collecting system removes fumes and condensation from the cooking kettles. General plan of the system is an individual hood and branch for each kettle. The branches are tapped into the main, which in turn empties into an expansion chamber, the top of which is out-of-doors.

Four fans, each handling 12,560 cfm and each driven by a 10-hp motor, are used.

About 10,000 lb of copper was used for this system.

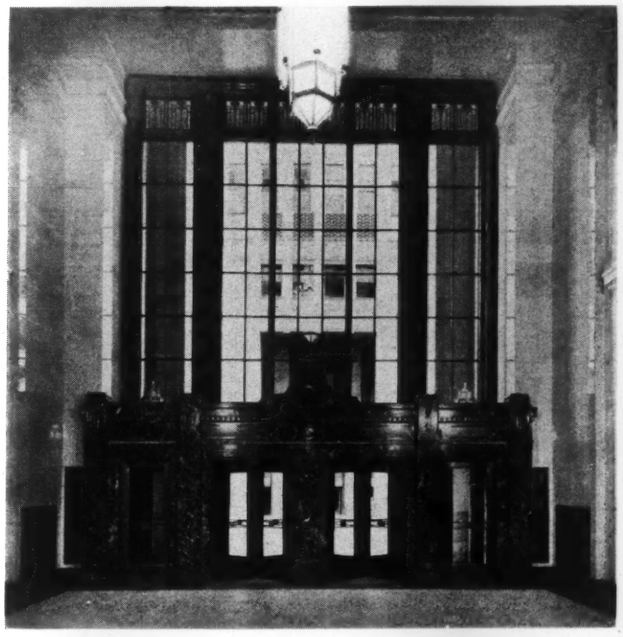


Fan-Motor and Riser-Valve Control

in a Partially-Air-Conditioned Building

By R. C. Allen*

Fig. 1—Impressive entrance to the 40-story Gulf Building, which has natural window ventilation for upper floors, humidified air for lower floors, clock and zone control for the steam radiation



IN the modern large building, supplying or conditioning air are major problems which must be studied not only from the standpoint of the comfort and satisfaction of the tenants but also for the economical and flexible operation of the heating system. The local atmospheric conditions during the entire year, the size of the floors or rooms, and the type of occupancy all have a bearing on this study and the final conclusions. The question of air conditioning—whether complete with refrigeration or partial with air washing and tempering—is important.

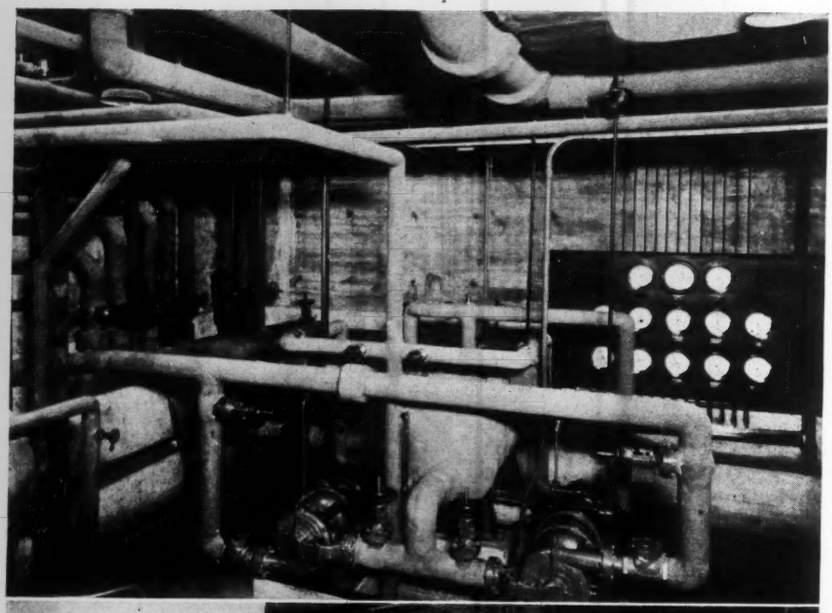
In all of this the electric drive plays an important part. There is alternating current or direct current, with entirely different motor and control characteristics, and constant speed or adjustable speed for blower capacity control. This article briefly describes the ventilating system used in the Gulf Building, Pittsburgh, Pa., and the results of the study of the building characteristics on the heating and ventilating arrangement.

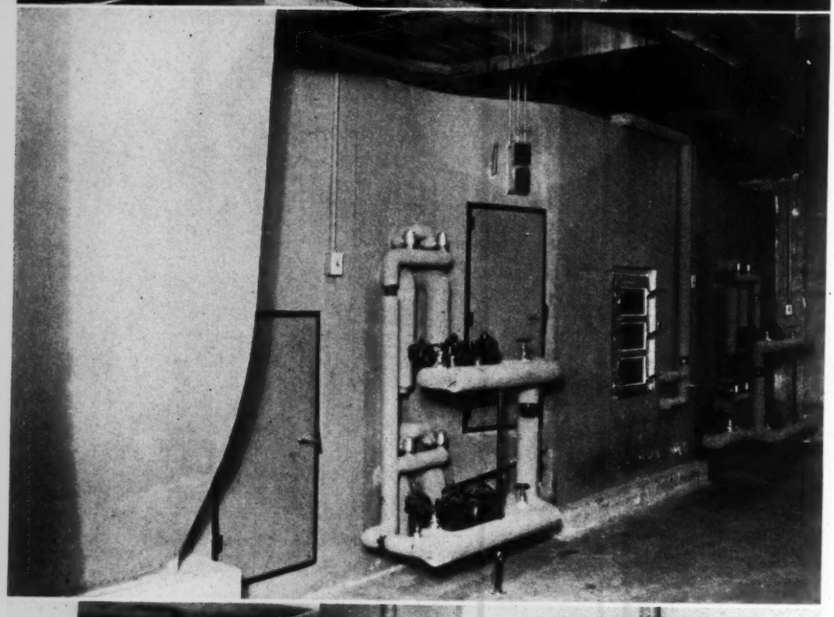
*General Engineer, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

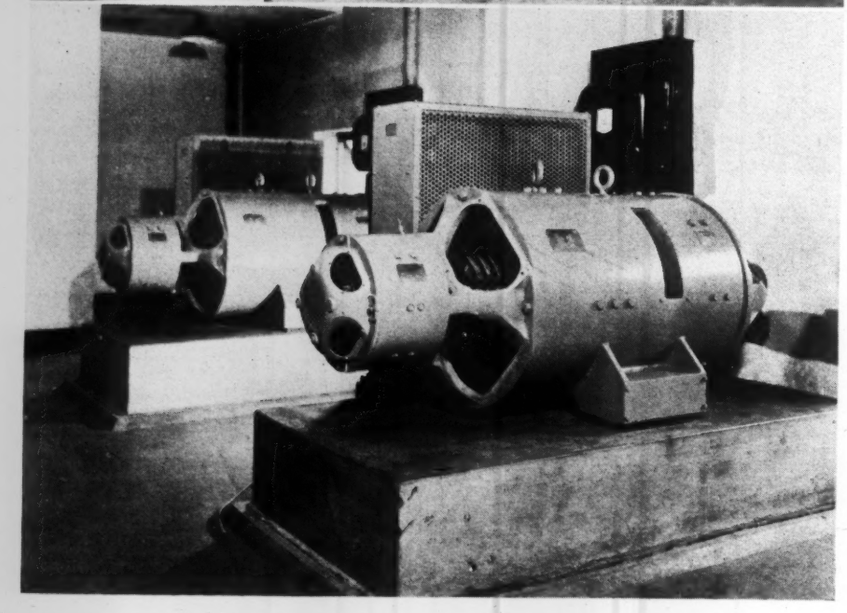
Building Is Forty Stories High

The building is 40 stories high, crowned by a pyramidal top that terminates in a great lantern designed to glow at night with the special orange color adopted by the Gulf Refining Company. At the street level the building is 195 ft by 135 ft and above the 7th floor, where the main set-back occurs, it is 108 ft by 108 ft. The vaulted entrances from the three fronting streets, all on different levels, lead to the elevators in the center

***PARTIALLY** air conditioned is the Gulf Building, lower floors being supplied with tempered, humidified air; upper floors have natural ventilation . . . . . The various risers for the vacuum-return heating system are controlled by electric steam valves, the cycle being governed by an electric clock system based upon outside temperature, wind direction, sun effect, and experience . . . . . Fan-motor control consists of manual adjustable resistance-type secondary speed controller for 50 per cent speed adjustment*







of the building (Fig. 1). The street floor is occupied by stores and the upper floors by offices. A basement, basement mezzanine, and sub-basement provide adequate space for the building machinery and working quarters, as well as storage for the tenants.

In the upper floors, above the set-back, the elevators and stairways, together with spacious halls, occupy the center of the building. This provides all offices with direct outside light and window ventilation. In studying the problem of heating and ventilating it was found that these offices were of a size in which natural window ventilation could be controlled by the occupant to give a reasonably satisfactory air condition throughout the room. Steam radiators, located under the window, are hand-controlled. The conditions of heat and air for each room are therefore within the control of the occupant and are not the responsibility of the engineer or building superintendent.

Zone and Clock Control of Steam

Steam for heating is purchased from the local central-heating plant and stepped down to the requirements of the low-pressure vacuum-return heating system (Fig. 2). As is customary for buildings of this character, steam is fed by numerous risers to different sections of the building and the pressure in these risers is regulated as required by the building exposure, as well as the season of the year.

In addition to this, except for unusual cold weather when full and continuous radiator capacity may be required, steam is fed to the risers, and consequently to the radiators, on a definite time cycle of a duration to keep the radiators at the necessary average temperature. This cycle is governed by an electric clock system which can be set up for any combination of day and

Fig. 2 (top)—Vacuum return condensate pumps for the heating system; the return pipes for the various risers are seen entering the common header. Fig. 3 (middle)—Air-conditioning unit with blower, heating units and spray washer; air enters direct from the outside through shut-off dampers. Fig. 4 (bottom)—Motor drive for the air-conditioning unit shown in Fig. 3, with manual speed controller

night operation desired by means of adjustable pins on a 24-hr dial. At the time intervals of the particular set-up, the electric steam valves to the risers are opened or closed; each riser has its own cycle for normal operation based upon the outside temperature, the direction of the wind, the effect of sun and to a great extent upon experience. This methods of operation gives very satisfactory heating as it keeps the radiators at an average temperature more than adequate for usual conditions. For an unexpected or unusual outside condition, or an individual call for heat, hand control can be resorted to, thus shunting out the clock control either temporarily or entirely.

Humidified Air for Lower Floors

In the lower office floors, and the street and basement floors, the size and location of the offices and stores necessitated mechanical ventilation. This consists mainly of three systems—one for the 1st to 4th floors inclusive, another for the basement and basement mezannine and the third for the sub-basement. The sub-basement, where the steam piping and machinery are located, is supplied with unheated washed fresh air, but in the other two systems the air is heated also after going through the spray washers (Fig. 3). These areas, served by the latter, therefore receive conditioned air in that by proper mixing and thermostatic control, the moisture content of the air, or relative humidity, is controlled also. Refrigeration for complete summer air-conditioning control was not considered necessary for this particular building because of the relatively few days it was expected such a system would actually be required. Each system has its exhaust fan so that a constant supply of agreeable and well-distributed fresh air is furnished the tenants in these zones. Toilets are ventilated by two risers with exhaust fans located on the 39th floor. All of the main exhaust fans are arranged, by means of suitable dampers, to be discharged from either of two outlets depending upon the direction of the wind.

In addition to the above, a bank and a drug store, both located on the street floor, have individual auxiliary heated air supply which is under the direct control of the occupant and used depending upon the particular weather conditions. At the revolving doors a stream of warm air is fed to the incoming side, thus eliminating this aggravating source of cold air.

The main ventilating system, therefore, consists of the following:

Apparatus No.	Location	Duty
S1	SB floor	Cold fresh air supply to SB.
S2	SB floor	Heated fresh air supply to B & BM.
S3	SB floor	Heated fresh air supply to 1st to 4th flrs.
E1	SB floor	Exhaust air from SB.
E2	SB floor	Exhaust air from B & BM.
E3	4th floor	Exhaust air from 1st to 4th flrs.
E4	39th floor	Exhaust air from west toilets SB to 38th Fl.
E5	39th floor	Exhaust air from east toilets SB to 38th Fl.
	6th floor	Exhaust air from loading platform 1st floor.
	39th floor	Fire-place flue exhaust 31st floor ex. offices.
	BM floor	Heated air supply to bank on 1st floor.
	B floor	Heated air supply to drug store 1st floor.
	6th floor	Freight elevator machine room exhaust 6th fl.

Control of the Fan Motors

The electric drive for these fans consists of wound-rotor motors with V-belt drives to the blower pulleys. The control consists of manual adjustable resistance-type secondary-speed controller for 50-per cent speed adjustment and a primary magnetic panel. This equipment, together with the safety disconnect switch, is mounted on a pipe frame-work adjacent to the motor, as shown in Fig. 4. Overload protection is of the thermal type mounted with the primary panel.

The primary contactor is interlocked with the speed-control handle so that the handle must be in the *off* or *resistance-all-in* position before the unit can be started. The first notch of the regulator closes the primary contactor and further movement of the handle reduces the secondary resistance in steps bringing the motor up to the desired running speed.

The motor is shut down by returning the handle to the *off* position. In case of an undesired shut-down, due to voltage failure or overload tripping, the unit will not start up until the control handle has been returned again to the starting position. This prevents the motor being started with all or part of the resistance cut out, which might cause an undesirable current surge or strain on the driven equipment.

No remote control for these motor drives is used but all starting, stopping, and speed regulation is done locally at each fan-motor control. The fans are not numerous nor does the service require frequent changes, so the engineer or his assistant can readily, and with no appreciable loss of time, make what speed changes are necessary, particularly as most of the blowers are located in the sub-basement.

Power is from the local central station network distribution system, located in the sub-basement and the 39th floors, at 199 volts, 3-phase, 60 cycles while the motors are wound for standard 200 volts. The motors are therefore operating within the standard allowable voltage variation of 10 per cent, which is quite satisfactory for fan drives and the like, especially on such steady and reliable circuits as maintained by network systems.

FLOW AND PRESSURE-DROP Calculations for Process Piping

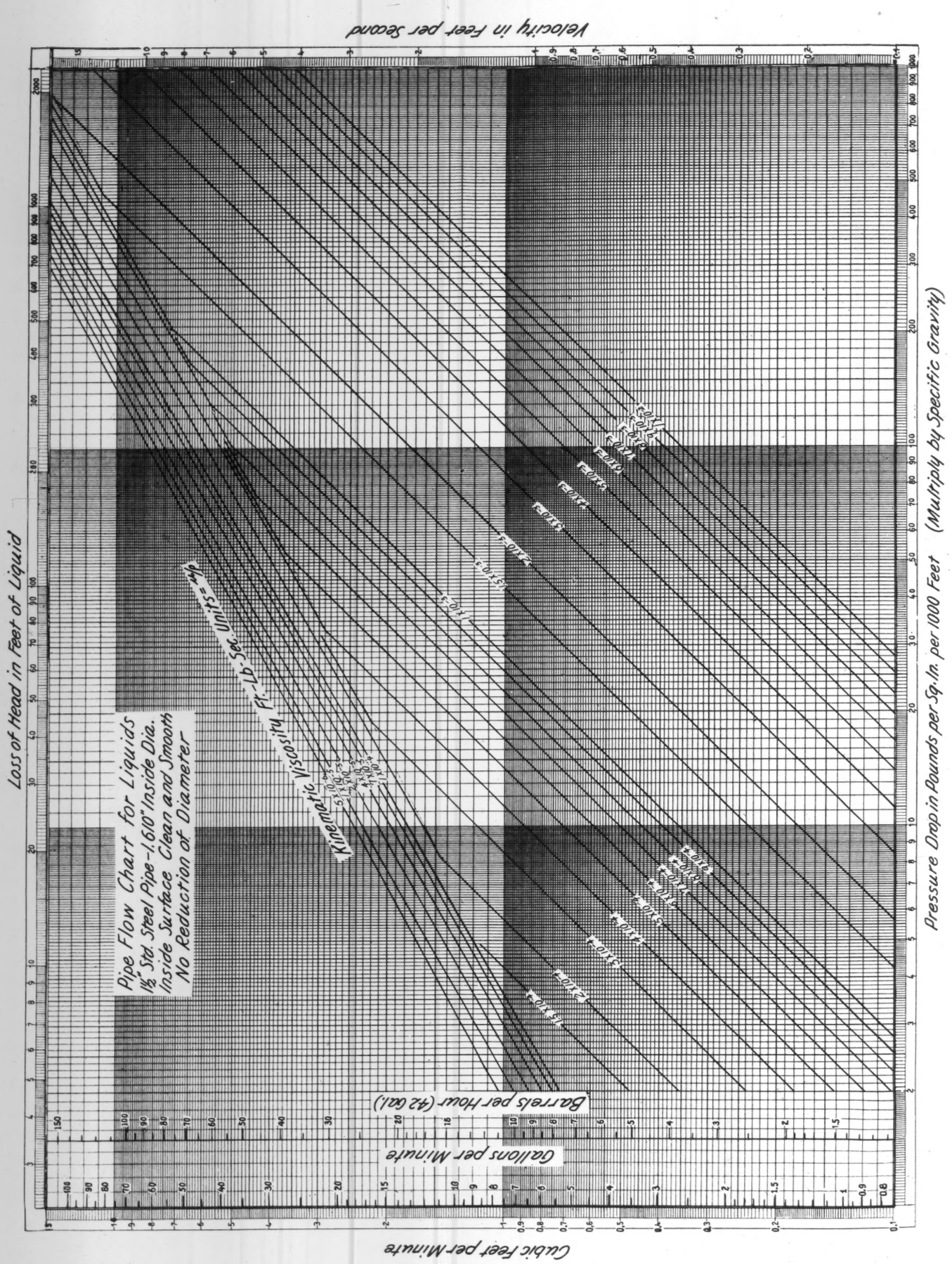
By **Emory Kemler***

ON THE next page is a chart designed to facilitate the making of pressure-drop calculations for liquids of various kinematic viscosities flowing in 1½-in. pipe. The complete series is planned to cover standard pipe sizes from ¼ to 4 in., the viscosities being chosen to cover a range that will take care of any ordinary process fluid that is being piped.

The first two charts to be published appeared in the October, 1933, issue and were for 1-in. and 2-in. sizes. An explanation of the charts and an example of their use also was published in October, as was a conversion chart for kinematic viscosity and viscosity in Saybolt seconds. Allowing for roughening and accumulations and turbulent flow were also discussed.

This explanatory material in the October issue should be referred to in connection with use of the chart published this month.

*University of Pittsburgh, Pittsburgh, Pa.


Velocity in Feet per Second
Loss of Head in Feet of Liquid
Pipe Flow Chart for Liquids
1½" Std. Steel Pipe - 1.610" Inside Dia.
Inside Surface Clean and Smooth
No Reduction of Diameter
Kinematic Viscosity
Ft.-Lb.-Sec. Units = ν/ρ
Pressure Drop in Pounds per Sq. In. per 1000 Feet (Multiply by Specific Gravity)
Barrels per Hour (42 Gal.)
Gallons per Minute
Cubic Feet per Minute

A Method of

CLEANING RADIATORS

By G. D. Winans*

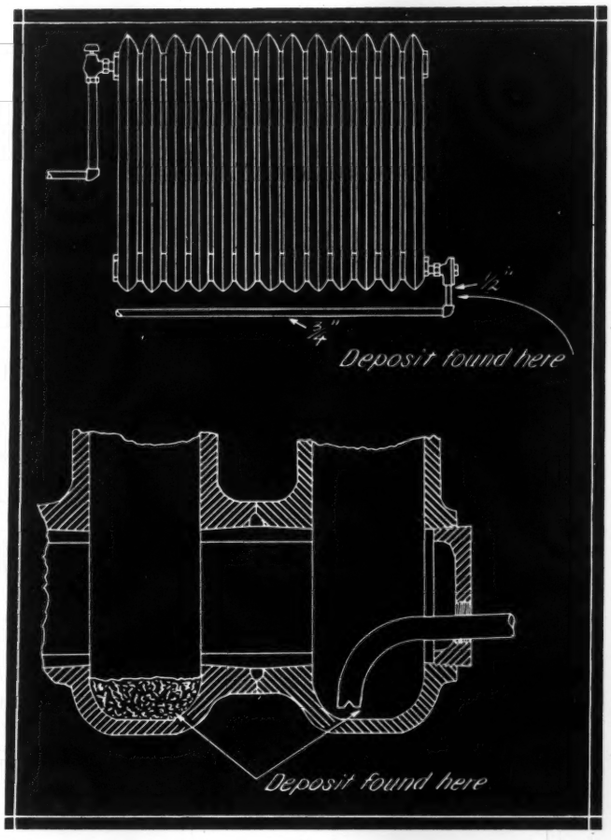


Fig. 1—*Complaint:* Thermostatic traps on radiators plugged; would not allow water of condensation to pass . . . *Cause:* Recesses in bottom of radiator sections contained considerable dirt

IT sometimes happens that portions of the return piping of a heating system near the radiator outlets become clogged with what appears to be products of corrosion. Although this is found infrequently, its occurrence causes serious troubles. In several cases, this plugging is found to be caused by dirt and scale from the piping system rather than by corrosion products.

A case of this kind was encountered when a large club building complained that many of the thermostatic traps on the radiators were plugged and would not allow water of condensation to pass. The heating system had been in operation for three seasons. Investigation showed that the traps were partially plugged and that the outlet nipple of the trap was, in many cases, clogged to such an extent that the flow of air and condensation was greatly retarded. Upon examination the recesses in the bottom of the radiator sections were found to contain considerable dirt, as indicated in Fig. 1. Examination of the steam supply piping revealed no signs of dirt or deterioration from corrosion.

It was evident that the dirt which was causing the trouble was that found in the radiators. Gradually this dirt was being carried into the return lines by the condensate and deposited in the trap and the return piping just beyond the trap. The trouble, therefore, would be remedied by the removal of the dirt from the radiator.

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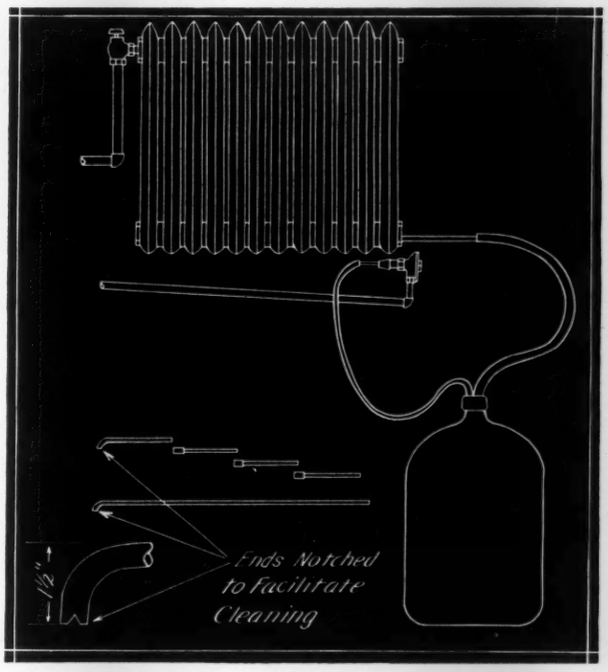


Fig. 2—*Remedy:* Method of "vacuum cleaning" radiators in place devised (operation explained in text) . . . *Results:* Very satisfactory

At first it was thought that the dirt could be removed by washing the radiators with a stream of water, and in order to try this, several radiators were removed from the piping and taken to the basement and washed. The end sections were removed after washing, and it was found that only a small portion of the dirt had been removed. The washing was not effective beyond the first two or three sections.

Method of "Vacuum Cleaning" Radiators Devised

Because the washing required the removal and handling of the radiators and produced unsatisfactory re-

sults, a method of vacuum cleaning the radiators in place was devised. A ½-in. water hose and a $\frac{5}{16}$-in. hose were connected into the neck of a 5-gallon water bottle, as shown by Fig. 2. The other end of the $\frac{5}{16}$-in. hose was fitted with a tail piece of a radiator trap while the other end of the ½-in. hose was fitted to a ¼-in. pipe. To clean a radiator, the trap tail piece was removed from the radiator and the ¼-in. pipe with a turned-down end was inserted into the opening. With the vacuum pumps running and maintaining eight inches of vacuum on the system, and with the $\frac{5}{16}$-in. hose connected to the trap, the dirt which was near the end of the ¼-in. pipe was drawn into the bottle. By using short sections of pipe which could be coupled together, each section of the radiator was cleaned.

After the first cleaning, about 2 quarts of water were poured into the radiator through the inlet valve union, which had been disconnected. This water was then drawn into the bottle along with additional dirt through the ¼-in. pipe. This washing was repeated until the radiator was clean, the cleanliness of the radiator being determined by the clearness of the water drawn out (two washings were sufficient in most cases). In addition to cleaning the radiator it was also found necessary to remove the radiator traps and the nipple on the discharge of the trap for cleaning. This was easily done by wiping the element and the inside of the trap with a rag. The deposit in the nipple was removed with a short rod since the nipples were in all cases less than six inches in length.

Results Very Satisfactory

This method of cleaning radiators has proved to be very satisfactory. The time for cleaning, including that for experimenting and disconnecting, averaged 35 minutes per radiator, and an average of six cubic inches of dirt was removed from each. Since cleaning, this heating system has operated two seasons without any further indication of sediment in the traps and return piping. This method of cleaning was recommended for the heating systems of two other buildings, and the results were equally satisfactory

If no vacuum pump were installed on the heating system, a cleaning device consisting of a small motor-driven pump discharging water through an ejector could be used to create a vacuum. The cleaning water could be pumped into the radiators if a proper system of valves were used.

Much of the trouble with dirt in heating systems can be avoided by specifying that radiators be delivered washed and plugged and that all pipe must be reamed and stood on end and pounded to remove any foreign material before erection. Where these precautions have been carefully followed, little trouble is experienced with dirt.

A Decade of Progress in Motor Control is Shown by These Jobs

THE left view shows the control equipment supplied for the control of fans, pumps and similar items used in large office buildings ten or twelve years ago. The other shows the same type of equipment as applied today. There are a great many of the older type in service today, which could be replaced to advantage with more modern equipment.

The following is a comparison of the two installations shown, both being the product of the same company. Other manufacturers have made comparable advances:

Old

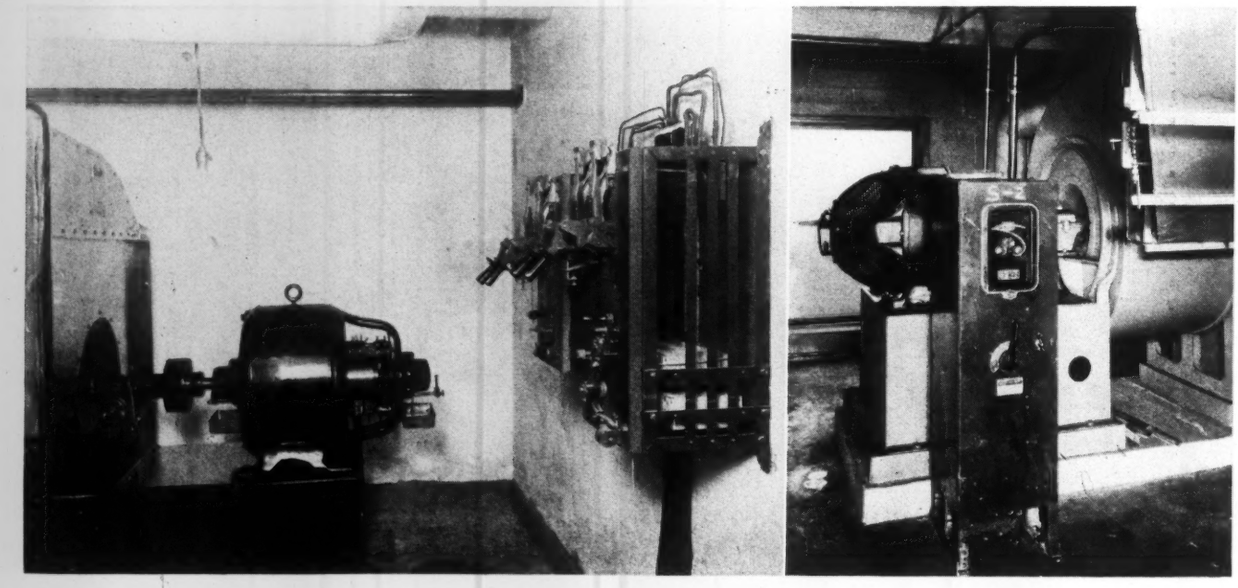
1. Open circuit breaker
2. Open controller
3. Open wiring between conduit and controller terminals
4. Wall mounted
5. Open motor
6. Sleeve bearings (note improvised drip pan to catch surplus oil).

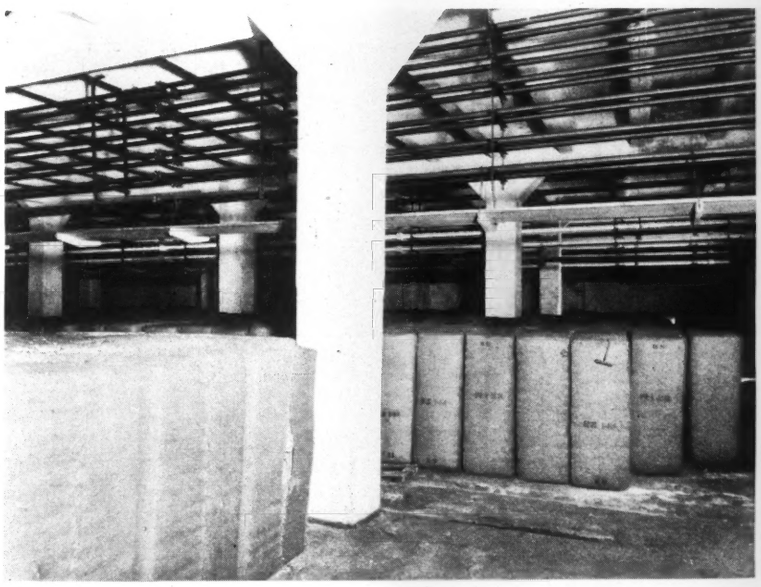
New

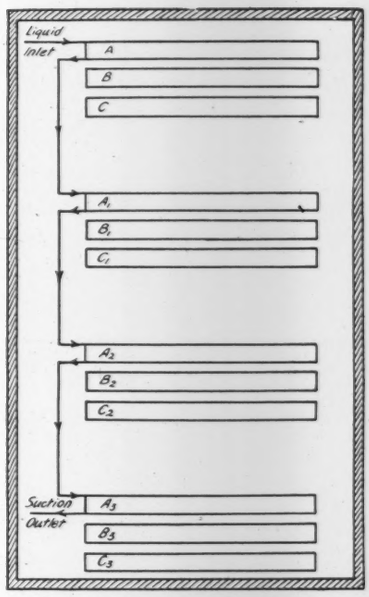
1. Totally-enclosed circuit breakers
2. Totally-enclosed starter arranged for outside operation
3. No exposed wiring, conduit runs directly into starter enclosure
4. Self-supporting floor-type frame
5. Semi-enclosed motor with protecting cover over commutator and brushes
6. Ball bearings.

Individual control units of the type shown in the right-hand view can be mounted side by side, and the adjacent side plates removed so as to form a continuous dead front totally steel enclosed switchboard of uniform construction and neat appearance.*

*Photographs courtesy of F. U. Webster, Cutler-Hammer, Inc., Milwaukee, Wis.







Left—Pipe coils arranged in banks across a large hop-storage room along the same general plan as illustrated in the sketch. Some of the coils are frosted up, while others are being defrosted. The troughs suspended from the coils carry away the water when defrosting. Right—General system of hooking up cooling coils in a cellar

Coils A, A_1, A_2, A_3, are connected in series. Coils B, B_1, B_2, B_3, and coils C, C_1, C_2, C_3, are also connected in series. Sufficient coils are provided so that two series in service can hold the temperature of 33 to 34 F while the remaining series is being defrosted.

Brewery-Cellar Piping

By **Robert S. Wheaton***

FEW people realize the truly enormous size of big brewery storage cellars. A typical installation may consist of 400 steel tanks, each tank holding 500 barrels of beer, a total of 200,000 barrels of beer being in storage at one time. To keep these storage cellars at a constant temperature of 33 to 34 F, many miles of refrigeration piping is required. To fabricate this piping and get it in the building involves considerable work, each step of which must be in accordance with modern and up-to-date practice.

Of course, the most important thing is the lay-out of the piping, and one method of doing this is indicated in the accompanying sketch. It will be noted that the coils are distributed throughout a cellar so that no matter which series of coils are in service the refrigeration is evenly distributed over the entire cellar.

After the design has been determined upon, the next step is to get the inserts for the hangers for the piping in place before the concrete contractor begins casting the ceilings. This is very important because any inserts which have to be placed by drilling into the ceiling involve a severe expense. Another point which should receive careful thought and attention when laying out the coils is to try to make it possible to get long lengths of pipe into the building; it is wasteful to use 20-ft lengths of pipe when 40-ft lengths could be used. Two-inch piping is readily available in 40-ft lengths which can be made into so-called "hair-pin" bends approximately 20 ft long. The centers between the pipes can usually be made 8 in. or more, which eliminates the necessity of heating the pipe when bending it and constitutes a saving in the cost of construction. The bearing bars for the coils can be made of angle iron and the hangers of round iron with long threads on them to facilitate the levelling and the erection of the coils. 2,500 to 3,000 ft of pipe can be placed on an ammonia expansion valve or expansion cock. The old style ammonia expansion cock is preferred in some cases because the adjustment of the cock can be seen at a glance by the cellar man, although some styles of expansion valves are also fitted with indicators showing the valve opening.

The refrigerating load which must be handled consists of the heat infiltration through the walls and roof of the building and the heat which is generated in the beer storage tanks by a secondary fermentation (set up in the beer in storage). At certain times in the winter, when the outside temperature is much lower than the room temperature, the refrigeration can be shut off and the heat generated by the secondary fermentation will result in the cellar being at the desired temperature.

This type of construction has quite a long life and, although appraisal companies sometimes figure a 12-yr amortization on refrigerating piping, it is not unusual for the refrigerating piping in a brewery cellar to remain in service for 30 or more years. As a matter of record, recent building operations in a large brewery disclosed piping placed in service 41 years ago which is in fairly good shape. However, it seems better to figure a 12-yr amortization, because something which would make the piping system obsolete (if not a liability) within the next twelve years may be invented.

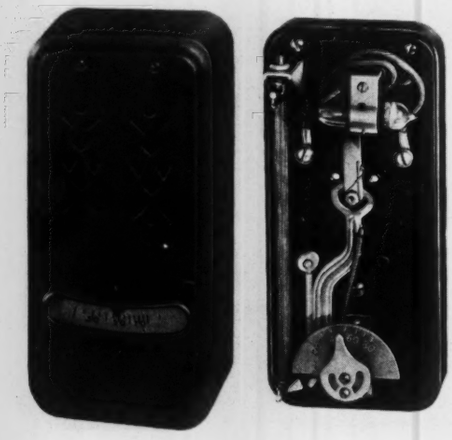
*Experimental Engineer, Milwaukee, Wis.

INTERESTING Equipment..... Developments

Room-Type Humidity Controls

A new line of room-type relative humidity controllers has been made available by the Minneapolis-Honeywell Regulator Company, Minneapolis, Minn. Built in various models providing for different electrical circuits and available with or without relative humidity indicators, this new line has been designed to offer accuracy and sensitivity in the control of humidity for small commercial installations.

Actuated by a hygroscopic element composed of multiple groups of human hair a simple lever mechanism transmits the motion of the expanding and contracting element to a mercury switch which, in turn, operates the humidifying or dehumidifying equipment. Ample electrical capacity is available for the direct control of line-voltage solenoid water valves or small motors. With other circuit arrangements motorized valves may be controlled, or when using the humidity control as a pilot control of a magnetic starter, larger loads may be controlled, limited only by the load rating of the starter.

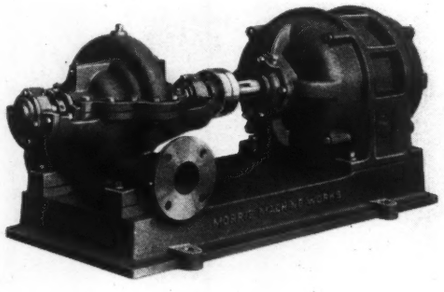


Designed particularly to meet the needs of room control of humidity they are arranged to provide accurate control and to perform dependably over long periods of time. Models are available with indicators built in their covers to show at a glance the relative humidity in the room. Although constructed for setting over a range of 20 per cent to 80 per cent relative humidity, the setting pointer is internal and not subject to tampering by persons unfamiliar with humidity requirements. The covers enclosing the control mechanism are of the locking type requiring a special key to provide access. These controls will, under conditions of normal rate of increase or decrease in relative humidity control within a total variation (differential), of 2 per cent, according to the maker.

High-Speed Pumps

A new line of double-suction split-case pumps specially designed for operation at high speed has been announced by Morris Machine Works, Baldwinsville, New York. These pumps have been developed to provide a suitable unit for direct connection to electric motors or steam turbines operating at 3500 rpm. They may also be belt-driven or operated through gears by low-speed drivers, such as gasoline engines.

While these high-speed pumping units follow the principles of standard centrifugal pump design, each element has special provisions to meet high-speed requirements, according to the manufacturer. The impellers, shaft and couplings are first individually tested for rotative balance and then the entire rotating unit is also similarly tested before the pump is assembled. The design and finish of the impeller are refined to minimize friction and eddy losses.



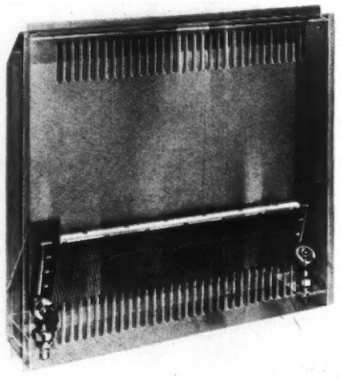
Deep groove, heavy-duty precision ball bearings are used on each side of the pump to take care of both radial and thrust loads, and the bearing supports, bed plate, pump casing, and shaft are all proportioned to provide rigidity.

These pumps are built in sizes from 1½ in. to 5 in. and are suitable for general pumping duty, factory service, chemical process work, municipal water supply, and for handling other liquids as well as water.

Announces Convection-Type Radiation

Warren Webster and Company, Camden, N. J., has recently announced a new type of radiation. The radiator is a lightweight, concealed convection type unit embodying in a single unitary structure a heating element consisting of aluminum fins on copper tubing, with an orificed radiator supply valve and union connection built integrally into one header and a ther-

[*To page* 70, *back section*]



Heating·Piping
and Air Conditioning

American Society of Heating and Ventilating Engineers JOURNAL SECTION

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Study of Summer Cooling in the Research Residence for the Summer of 1933

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This paper is the result of research conducted at the University of Illinois in cooperation with the A. S. H. V. E. Research Laboratory and the National Warm Air Heating and Air Conditioning Association.

The results presented in this paper were obtained in connection with a continuation of the summer cooling investigation (1933) in the Research Residence[1] (Fig. 1) at the University of Illinois, conducted by the Engineering Experiment Station under the direction of Acting Dean A. C. Willard, director of the Engineering Experiment Station and head of the Department of Mechanical Engineering. These results will ultimately comprise part of a bulletin of the Engineering Experiment Station. Special acknowledgment is due the National Association of Ice Industries, the Utilities Research Commission of Chicago, Illinois, and the General Electric Company for active cooperation in this investigation. Acknowledgment is also due to M. K. Fahnestock, Special Research Assistant Professor, E. L. Broderick, Research Assistant, and A. F. Hubbard, Special Research Graduate Assistant, for active participation in the detailed work of the investigation.

THE experience in the Research Residence, in which between 40 and 45 tons of ice were used during the summer of 1932[2], has shown that complete artificial cooling of this class of structures by such cooling agents as cold water or ice, or by mechanical or chemical methods, may be a very expensive process unless some modification is made in the conventional or usual methods of operation or in the structure itself. The most obvious modifications in the structure consist of the use of insulation in the walls and ceilings, and the use of awnings at the sun exposed windows. The use of awnings was investigated during the summer of 1932, and the use of insulation was considered outside of the immediate scope of this investigation. Thus attention was directed toward some modification in the operating schedule.

For the investigation during the summer of 1932 the windows and outside doors were kept closed as much as possible, and the ice plant was started whenever the effective temperature indoors reached a value of 75 F. During the periods of operation, both night and day, the effective temperature was maintained at approximately 72 F, corresponding to a dry-bulb temperature of from 78 to 80 F and relative humidity of about 45 per cent. However, a study of the temperature cycles indicated that the minimum outdoor temperature at night was always approximately 20 F lower than the maximum attained during the day, and that during a period extending from 9 p. m. to 6 a. m. the outdoor temperature was 7.5 to 10 F lower than that indoors. During this period the temperature of the inside surfaces of the walls was usually less than that of the inside air, so that all of the cooling of these surfaces had to take place by conduction through the wall to the outside air. Hence it seemed evident that if sufficient air at a temperature lower than that of the inside wall surface could be introduced, these surfaces could cool from the inside, and if the process was continued, the whole structure could be cooled, and the next day started with the entire structure filled with cool air, with the inside wall surfaces and contents at a temperature lower than would otherwise exist, and with the heat absorbing capacity of the material in the structure increased as a result of the lower wall surface temperatures. The investigation for the summer of 1933 was, therefore, undertaken with the object of determining to what extent the circulation of air taken from outdoors at night could be used to supplement ice cooling during the day, thus reducing the amount of ice required, and to what extent it could be used to eliminate the necessity for any additional cooling during the day. Incidental objects were to determine the relative merits of natural ventilation, of a fan in the forced-air heating system, and of a fan in the attic as means for circulating the air taken in from the outdoors at night, and, if possible, to determine the most advantageous time for opening the windows and starting the fan.

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[1]The Research Residence in Urbana, Illinois, was built, furnished and completely equipped specifically for research work in warm air heating by the *National Warm Air Heating and Air Conditioning Association* in December, 1924.

[2]Study of Summer Cooling in the Research Residence at the University of Illinois, by A. P. Kratz and S. Konzo. A. S. H. V. E. JOURNAL SECTION, *Heating, Piping and Air Conditioning*, February, 1933, p. 115. For presentation at the 40th Annual Meeting of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, New York, N. Y., February, 1934.

Fig. 1—View of Research Residence in Urbana, Illinois

Description of the Research Residence and Cooling Equipment

The Research Residence, shown in Fig. 1, together with the forced-air heating system and the ice-cooling plant have been described in a previous paper.[3] For the purpose of this investigation the Residence was equipped with awnings at all east, south, and west windows and the sun parlor was isolated from the rest of the house by means of the doors opening into the dining room. The entire third story was regarded as an attic and during the daytime was isolated from the rest of the house by means of a door at the head of the stairs. The attic windows, however, were opened to provide ventilation in the attic during both day and night. With the exception of the space above the northwest bedroom, the third story had hardwood floors laid on pine sub-flooring. In the space above the northwest bedroom one inch of insulating blanket was nailed to the upper edges of the floor joists. Hence, all second floor ceilings were at least equivalent to lath and plaster with flooring above it. No cooking was done in the kitchen, but the heat transmitted through the glass doors from the sun-parlor, which was not ventilated by opening the windows, compensated for this to a certain extent. In all respects the state of the Residence was comparable for the work done during both summers.

The arrangement of the forced-air heating plant and fan, hereafter referred to as the basement fan, is shown in Fig. 2. For the purpose of this investigation all of the return ducts were blocked unless otherwise specifically stated. For a few tests the outdoor air was taken into the fan through a connection from the nearest basement window. This connection was found to restrict the flow of air, however, and for later tests it was removed, and the fan was allowed to take air directly from the basement, the outdoor air coming in through the open basement door. This fan delivered from 1760 to 2142 cu ft of air per minute.

The arrangement of the attic fan is shown in Fig. 3. This 24-in. fan was installed in the doorway at the head of the stairs leading from the second to the third story. Thus the air was delivered into the attic space at a point approximately centrally located with respect to the horizontal plane of the third story. It was allowed to escape through windows on all sides. The use of a box and hinged damper on the suction side of the fan, as shown in Fig. 3, permitted outdoor air to be drawn into the open first and second story windows at night, or to be drawn through a duct from a third story window in order to provide positive ventilation for the third story during the day. This arrangement did not interfere with the full capacity of the fan for circulating the air at night, and the somewhat reduced capacity was more than sufficient for ventilating the attic during the day. The fan delivered approximately 4000 cu ft of air per minute.

Method of Conducting Tests

During the entire summer from May 23 to September 23, continuous records were made, by means of temperature recorders, of the following air temperatures: outdoor, dining room, kitchen, first story hall, living room, east bed room, southwest bed room, northwest

[3] Loc. Cit.

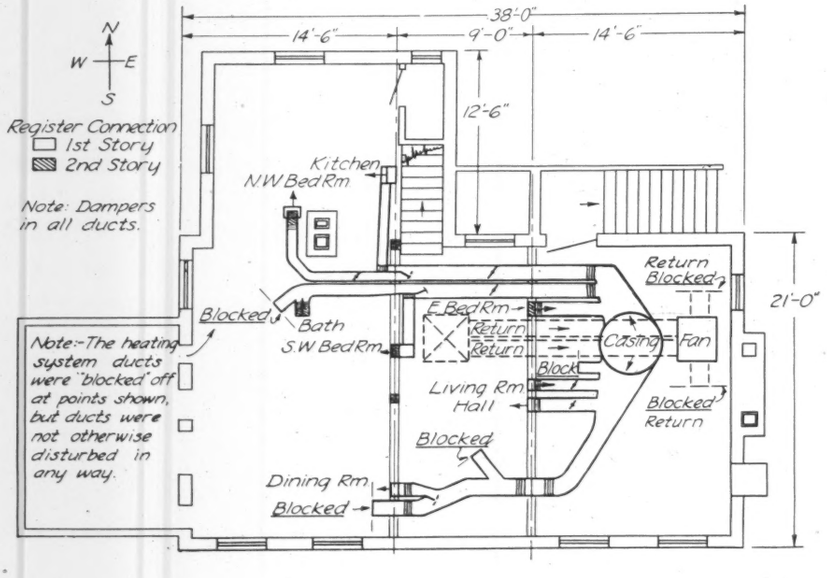

Fig. 2 — Basement plan, showing duct layout for forced-air system in use for distributing cool air

bed room, and third story hall. Other incidental air temperatures were observed at regular intervals. Relative humidities both indoors and outdoors were observed by means of an aspirating psychrometer. The outdoor dry-bulb reading on this psychrometer served as a check on the outdoor temperature read from the recorder chart. Surface temperatures of the north, south, and west walls and of the northwest bed room, east bed room, dining room and living room ceilings were observed by means of thermocouples. Thermocouples were also used to observe the surface temperature of tables in the dining room and east bed room. These data were plotted on a continuous chart, and this chart was used as a basis for the analysis of the results.

Twenty-four hours operation constituted a test, and for all tests, with the exception of those in *Series 12*, the attic was ventilated by natural circulation through the windows during the day. At night the natural circulation in the attic was employed for all series except those involving the attic fan. In the latter case the fan delivered the air into the attic, and the circulation was outward through the open windows. The Residence was operated strictly on the schedules described in connection with the following enumeration of the different test series:

Series 1. Restricted Natural Circulation.

8 windows, 4 on the first story and 4 on the second, were opened halfway at 9 p. m. and closed at 6 a. m. on the following morning. The attic door was kept closed.

Series 2. Maximum Natural Circulation.

All windows on both stories were opened wide from bottom and the attic door was opened at 6 p. m. and closed at 6 a. m. on the following morning.

Series 3. Restricted Basement Fan Circulation.

8 windows were opened halfway and basement fan started, circulating outdoor air, at 9 p. m. The windows were closed and the fan stopped at 6 a. m. on the following morning. (Comparison series with *Series 1.*) 1760 cfm fan delivery or 7.5 air changes per hour.

Series 4. Basement Air Recirculation.

Basement air was recirculated for short period in early evening hours with house closed up. This was followed by circulation of outdoor air by basement fan with all house windows opened wide (1 window in each of 3 second story rooms was opened from top) and attic door opened. The windows were closed and fan stopped at 6 a. m. on the following morning.

Series 5. Maximum Basement Fan Circulation.

All windows were opened wide (1 window in each of 3 second story rooms was opened from top), attic door was opened and the basement fan was circulating outdoor air at 6 p. m. Windows closed and fan stopped at 6 a. m. on the following morning. (Comparison series with *Series 2.*) 2142 cfm fan delivery or 9.1 air changes per hour.

Series 6. Day Cooling with Ice Plant.

The ice plant was operated in the day time until the outdoor temperature had dropped below the indoor temperature, when night air cooling was started, making use of natural ventilation, the basement fan or the attic fan as in *Series 2, 5,* or *8.*

Series 7. Attic Fan Circulation with Windows Opened Half Way (except halls).

The fan was operated from 6 p. m. to 6 a. m. on the following morning. 3980 cfm air delivery or 16.8 air changes per hour. (Comparison series with *Series 2* and *5.*)

Series 8. Attic Fan Circulation with Windows Opened Wide (except halls).

Same as *Series 7* except that the windows were opened wide. No difference in air delivery.

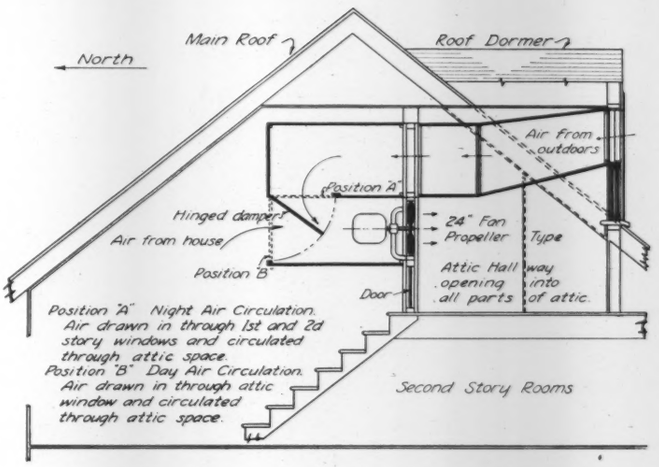
Main Roof
Roof Dormer
North
Air from outdoors
Position 'A'
Hinged damper
Air from house
24" Fan Propeller
Type
Position 'B'
Attic Hall opening all parts
way into of attic
Door
Position 'A' Night Air Circulation. Air drawn in through 1st and 2d story windows and circulated through attic space.
Position 'B' Day Air Circulation. Air drawn in through attic window and circulated through attic space.
Second Story Rooms

Fig. 3—Arrangement of attic fan in Research Residence

Series 9. Room Cooling Unit on First Story.

The room cooling unit was operated on first story in day time. Night cooling with the attic fan same as in *Series 7* and *8* except for starting time.

Series 10. Attic Fan Circulation with Only Second Story Windows Open Wide.

The fan was operated from 6 p. m. to 6 a. m. on the following morning. 3980 cfm air delivery or approximately 33.6 air changes per hour on second story.

Series 11. Natural Circulation with Only Second Story Windows Open Wide.

Same as *Series 10* except natural circulation in effect. Attic door open.

Series 12. Attic Fan Circulation in Day Time Through Attic Space Only.

Night circulation same as *Series 8* attic fan circulation.

For the purpose of comparing the fan circulation with natural circulation these series may be divided into three related groups. The first group consists of *Series 1* and *3*, the second of *Series 2, 5, 7* and *8*, and the third of *Series 10* and *11*. Other comparisons, of course, may be made between groups.

When night cooling with outdoor air was used to supplement cooling with ice in the daytime, as in *Series 6*, the cooling plant was adjusted so that the rate of ice meltage could not exceed the equivalent of 700 lb, exclusive of the basement loss, in about 5 hours. After closing the windows and stopping the fan in the morning the indoor temperature was allowed to rise until it reached 81 F, at which time the cooling plant was started. This was allowed to operate at a constant rate until the entire 700 lb of ice were melted unless the indoor temperature decreased below 79 F, or unless the outdoor temperature dropped more than 3 F below the inside temperature. In the case first mentioned, the cooling plant was stopped until the inside temperature again rose to 81 F. In the second case the cooling plant was stopped for the night and the windows were opened and the fan started. Whenever the ice plant was stopped before the time that the windows were opened, the pump was stopped, thus discontinuing the circulation of water through the cooling coil, but the fan was allowed to run in order to maintain recirculation of the air in the house. The 3 F difference between indoor and outdoor temperatures was allowed in order to provide for the difference in relative humidity indoors and outdoors. The latter difference was such that it required about 3 F lower

Table 1—Fan Data

Test Series	Designation of Fan	Windows	Time of Operation	Air Volume CFM[a]	Air Changes per Hour	Kilowatt-hours per 12 Hours	Speed RPM
3	Basement	8 windows open	9 p. m. to 6 a. m. Night Air	1760	7.5	4.50	567
4, 5 and 6	Basement	All windows open[c]	6 p. m. to 6a. m. Night Air	2142	9.1	5.40	567
4 and 6	Basement	Windows closed. Recirculation	Daytime	1482	6.3	4.20	567
7 and 8	Attic	All windows open	6 p. m. to 6 a. m. Night Air	3980	16.8	3.85	845
10	Attic	2nd story windows open only	6 p. m. to 6 a. m. Night Air	3980	33.6[b]	3.85	845

[a] Based on density of air of 0.074 lb per cu ft.
[b] First story windows closed and only second story regarded as active.
[c] Basement air taken through basement door. Inlet duct open to basement.

dry-bulb temperature outdoors in order to have the same effective temperature both indoors and outdoors. If the windows were opened before these two effective temperatures were equalized it resulted in an undesirable increase in effective temperature indoors.

Results of Tests

Influence of Methods of Operation on Conditions at Night

A study of the results involves the recognition of three separate natural subdivisions or objectives. These are: (1) the study of the conditions at night, between the times of opening and of closing the windows, as influenced by the weather and by the different methods of operation; (2) the study of the conditions in the house the next day resulting from the weather and from the conditions existing at 6 a.m. when the windows were closed; (3) the prediction of the effectiveness of a given method of operation, or of the cooling required, from the weather reports of a particular summer season.

Table 1 shows the volume of air delivered per minute and the number of air changes per hour produced by the different fan arrangements used, together with the power required to operate the fans. Fig. 4 shows characteristic curves for outdoor temperatures, indoor temperatures and indoor relative humidities for the least and most favorable methods of operation for two similar days. In the first case, shown by the upper curves in Fig. 4, 8 windows were partly opened at 9 p.m. and no fan was used. During the early morning hours of June 18 the outdoor temperature reached a minimum of 65.0 F, while the indoor air temperature did not fall below 75.5 F, or a difference of 10.5 F was shown. During these hours the indoor air temperature remained equal to or slightly above the temperature of the inside surface of the exposed walls, thus permitting no transfer of heat from the walls except by conduction to the outdoor air. The temperature of the air in the house rose to 84.5 F on June 18 following this cycle of operation at night.

In the second case, shown by the lower curves in Fig. 4, the lower sash of all of the windows, which were double hung, was opened to the fullest extent at 6 p.m. and the attic fan was used. The minimum outdoor temperature in the early morning hours of August 12 was 64.0 F, nearly the same as in the first case, but the indoor air temperature dropped to 68.0 F as compared with 75.5 F for the first case. That is, the difference between indoor and outdoor temperatures was 4.0 F as compared with 10.5 F. During the whole night the temperature of the indoor air was distinctly below that of the inside surface of the exposed wall, thus permitting heat to be transferred from the walls to the air which was being removed from the house. The temperature of the air in the house next day rose to only 79.5 F before the windows were opened as compared to 84.5 F for the previous case.

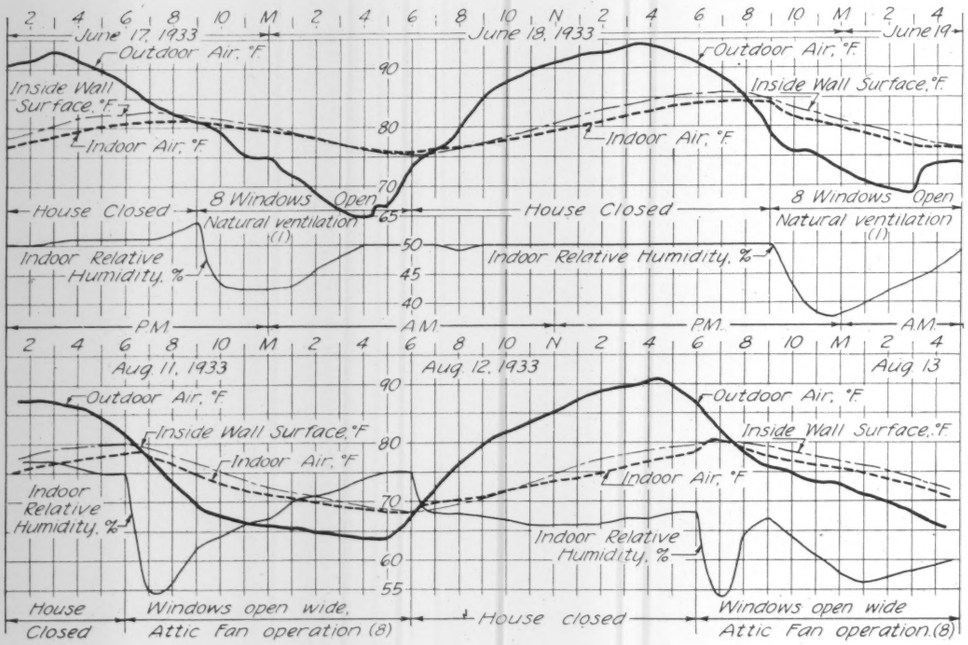

Fig. 4—Daily temperature cycles showing periods of night cooling with least and most favorable methods of operation

In all cases, the temperature of the surface of the first floor ceilings and of the furniture remained practically the same as that of the indoor air of the room involved. The temperature of the surface of the second floor ceilings was usually from one to three degrees higher than that of the air in the room. (See Fig. 8.)

From Fig. 4 it may be observed that conditions in the house at 6 a.m. when the windows were closed were directly dependent on the weather and the method of operation between the times of opening and closing the windows. Since the house was always closed and no fan was operated in the daytime, conditions in the house the next day were determined by the conditions existing at 6 a.m. and by the weather during the day. Inasmuch as these conditions at 6 a.m. were dependent on the method of night operation, the conditions next day were a reflection of the method of operation. But since the conditions at 6 a.m. could be considered as having been established by any independent means, and the resulting conditions during the day would be the same independent of the means required to establish those at 6 a.m., for purposes of analysis of the different methods of night operation the daytime conditions may be regarded as not directly dependent on these methods, and the attention may be concentrated on the part of the cycle included between the times of opening and closing the windows.

The effectiveness of any given method of night operation is directly indicated by the ratio of the rate of decrease in the indoor temperature to the rate of decrease in the outdoor temperature, and the relative effectiveness of the different methods could be compared by comparing these ratios. However, the rates of decrease are also proportional to the drops in temperature from the time that the indoor and outdoor air attain the same temperature, as represented by the crossing point of the two air-temperature curves shown in Fig. 4, to the times at which these two air temperatures each become a minimum. Since these temperature drops were useful in subsequent calculations, they were used as the basis of comparison, instead of the ratios of the rates of temperature decrease. These temperature drops are further useful in that with a known outdoor minimum temperature and a known or assumed temperature at the crossing point, they serve to establish the minimum indoor temperature that would be attained. That this minimum indoor temperature was also the same as the indoor temperature existing at the time that the windows were opened at 6 a.m. is shown by Fig. 5.

A comparison of the temperature drops, *A* and *B*, from the crossing point to the minimum outdoor and indoor temperatures for the different methods of night operation is shown in Fig. 6. The time of the crossing point was not always coincident with the time at which the windows were opened, and the temperature at the crossing point was somewhat influenced by the history between these two times. Hence in order to obtain the effect of the fan alone the comparison must be made between two series for which the windows were opened at the same time and which differed only in that the fan was used for one and not for the other. Other comparisons are valid, however, in that the temperature drop curves reflect the whole history from the time of opening the windows and this whole history is inherent in the particular series under consideration.

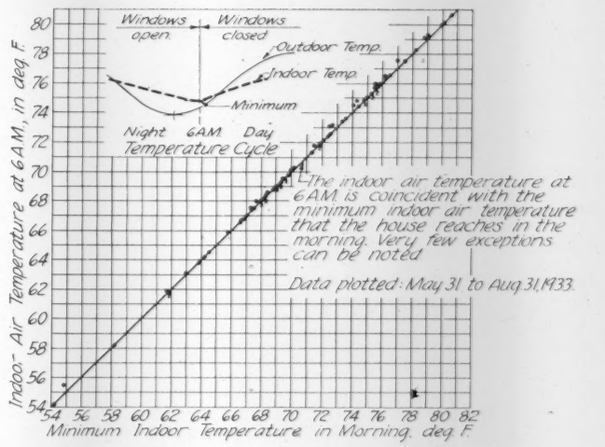
Windows open
Windows closed
Outdoor Temp.
Indoor Temp.
Minimum
Night 6 AM Day
Temperature Cycle
The indoor air temperature at 6 AM is coincident with the minimum indoor air temperature that the house reaches in the morning. Very few exceptions can be noted
Data plotted: May 31 to Aug 31, 1933
Indoor Air Temperature at 6 AM, in deg. F.
Minimum Indoor Temperature in Morning, deg. F.

Fig. 5—Indoor air temperature at minimum value at 6 a. m.

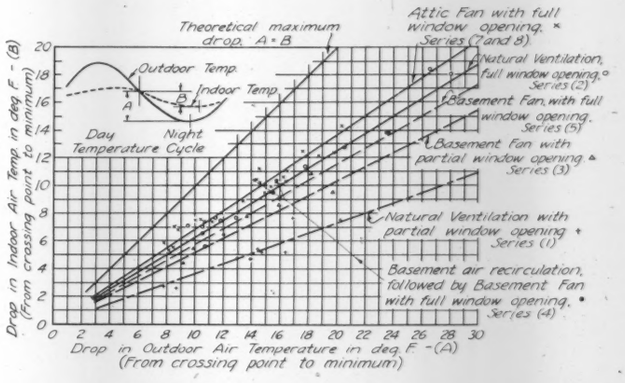
Theoretical maximum drop, A = B
Attic Fan with full window opening. × Series (7 and 8)
Natural Ventilation, full window opening. ○ Series (2)
Basement Fan, with full window opening. Series (5)
Basement Fan with partial window opening. △ Series (3)
Natural Ventilation with partial window opening + Series (1)
Basement air recirculation, followed by Basement Fan with full window opening. • Series (4)
Outdoor Temp.
Indoor Temp.
A
B
Day
Night
Temperature Cycle
Drop in Indoor Air Temp. in deg. F. - (B) (From crossing point to minimum)
Drop in Outdoor Air Temperature in deg. F. - (A) (From crossing point to minimum)

Fig. 6—Curves of temperature drops for various methods of night air cooling in Research Residence (summer of 1933)

From Fig. 6 it is evident that *Series 1* in which 8 windows were opened at 9 p.m. was the least favorable since it gave the least drop in indoor temperature for a given drop in outdoor temperature. The house was stuffy and uncomfortable all night and the temperature was far too high for comfort the next day. A companion series, *Series 3*, run with the same schedule of window opening and with the basement fan delivering 1760 cu ft of air per minute taken from outdoors, resulted in marked improvement, but did not entirely correct conditions.

From the experience with *Series 1*, it became evident that some advantage was to be gained by opening the windows earlier even if the outdoor temperature was somewhat higher than that indoors. *Series 2* was therefore run without a fan, but with all of the windows in the house opened to the fullest extent possible and in addition the attic door opened in order to obtain the advantage of the full chimney action of the heated air in the house. As shown by Fig. 6, this resulted in very marked improvement over the results from *Series 1*, and in considerable improvement over those from *Series 3*. Conditions in the house were quite comfortable at night and the indoor temperatures the next day were not unreasonable.

It is probable that the Research Residence was better

adapted to natural ventilation than the average type of residence would be. The attic was equivalent to a full third story and the dormer windows extended nearly the full height of the story. A 2.5 ft by 6.5 ft door at the head of the stairs provided ample area for the passage of air into the attic. Hence conditions were particularly favorable for obtaining and utilizing a relatively large chimney effect. In houses with only a small trap door in the second floor ceiling and small attic windows, this chimney effect might be greatly reduced.

Series 5 was run on the same schedule of window opening as *Series 2* but with the basement fan delivering 2142 cu ft of air per minute taken from outdoors. The results from this arrangement were not quite as favorable as those obtained with *Series 2* for which no fan was used. This can not be explained on the basis that favorable wind movement aided the natural ventilation in *Series 2*. The different points on the curves represented days covering the whole range of wind move-

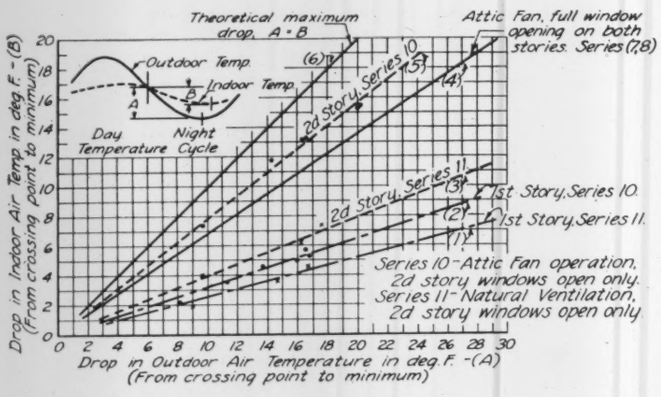
Theoretical maximum drop, A - B
Attic Fan, full window opening on both stories. Series (7,8)
Outdoor Temp.
Indoor Temp.
Day Temperature Cycle
Night
2d Story, Series 10
2d Story, Series 11
1st Story, Series 10
1st Story, Series 11
Series 10 - Attic Fan operation, 2d story windows open only.
Series 11 - Natural Ventilation, 2d story windows open only.
Drop in Indoor Air Temp. in deg. F. - (B) (From crossing point to minimum)
Drop in Outdoor Air Temperature in deg. F. - (A) (From crossing point to minimum)

Fig. 7—Curves of temperature drops for night air cooling by means of attic fan. (Research Residence data, summer of 1933)

ment at night and sun effect by day. During most of the season the nights were comparatively calm, and the wind velocity varied from 2 to 7 mph. Except for an occasional storm the days had a high percentage of sunshine. Hence, the most probable explanation appears to be that more air was circulated through the house as a whole by full natural ventilation than by the basement fan. It is also possible that in the latter case some of the air short-circuited out of the windows, although no positive evidence could be obtained on this point owing to the low velocity at the windows.

In *Series 4* an attempt was made to take advantage of the reservoir of cooler air existing in the basement by recirculating this basement air through the house for about one hour before opening the windows. This series is comparable with *Series 5* and the two points representing these tests are shown in Fig. 6. This method of operation represented a slight gain over the results from *Series 5*, but the temperature of the basement air soon rose to practically the same as that upstairs and the amount of gain can not be regarded as sufficient to offset the complication in the operating routine. Furthermore, this method of operation appeared to accentuate odors. With all of the different test series, there was a tendency for odors to become slightly noticeable in the afternoon, particularly on the second story, after the windows were closed in the morning, but not to the extent of becoming objectionable.

The most favorable results shown in Fig. 6 were obtained from *Series 7* and *8* in which the attic fan, drawing 3980 cu ft of air per minute into the first and second stories, was used. No difference was observed between *Series 7* for which the lower sash were raised half way, and *Series 8* for which they were raised all of the way. From Fig. 6 it is apparent that there was not a great amount of difference between the three most favorable methods of operation, and that even with the 16.8 air changes per hour produced by the attic fan the indoor temperature was not reduced to the same temperature as the outdoor air. The latter condition would be represented by the line designated as the theoretical maximum drop. The results of the tests indicate that considerable benefit may be obtained from the use of an attic fan drawing a generous amount of air into the house through the open windows at night. In a house similar to the Research Residence, having two full stories and an attic having dormer windows and a large attic door, practically as much benefit may be obtained without any fan by opening all of the windows and the door leading into the attic. In case it is not desirable to open a large proportion of the windows at night considerable benefit may be obtained from the use of either a fan in the attic or one installed in connection with a forced air heating system and drawing air from the outdoors. The power required, as shown by Table 1, ranged from 3.85 to 5.40 kw-hr for 12 hours of operation at night.

Series 10 and *11* were run with the attic fan and with full natural ventilation respectively, with the windows opened on the second story only. In this case all of the 3980 cu ft of air per minute was drawn in through the second story windows, giving 33.6 air changes per hr based on the cubic contents of the second story. The resulting temperature drops for the first and second stories are shown in Fig. 7. Comparing curve *No. 3* in Fig. 7 with the corresponding curve in Fig. 6, it is evident that the natural ventilation with full window opening was not as effective for the second story alone as it was when all of the windows on both stories were opened. Curves *Nos. 3* and *5* show that when the fan was used in connection with the second story alone there was more marked improvement than there was when it was used in connection with both stories. This is indicated by the fact that the distance between curves *Nos. 3* and *5* is greater than that between the corresponding curves in Fig. 6, and also by the fact that curve *No. 5* lies above curve *No. 4* which has been transferred to Fig. 7 from Fig. 6. Considering curve *No. 1* in Fig. 7, it is also evident that natural ventilation on the second story alone resulted in a very small temperature drop on the first story as compared with the average for the house shown in Fig. 6 resulting from natural ventilation on both stories, and while the use of the fan as shown in curve *No. 2* resulted in some improvement the drop was still not comparable with that occurring when either the fan or full natural ventilation was used in connection with both stories.

In order to determine whether there was any difference in cooling effect produced by the air movement resulting from the different methods of night operation

Kata-thermometer readings were made at the centers of the rooms. The results are shown in Table 2. The criterion for comfort as stated by Dr. Leonard Hill is that the cooling effect for the dry Kata should exceed 40 and for the wet Kata 135 Btu per sq ft per hr. Comparing the results from *Series 2* and *7* it appears that the use of the attic fan increased the air movement from a velocity of 3.2 to 12.2 ft per minute on the first story and from 2.8 to 4.2 ft per minute on the second. Since the wet- and dry-bulb temperatures were comparable for these two cases the Kata cooling effects are also comparable. The dry Kata cooling effect was increased from 42.6 to 48.8 Btu per sq ft per hr on the first story and from 37.6 to 44.9 on the second, and the wet Kata cooling effect was increased from 167 to 178 on the first story and from 158 to 168 on the second. All of these cooling effects were greater than the 40 and 135 Btu per sq ft per hr required for comfort.

Comparing the results from *Series 7* and *8* it may be noted that when the attic fan was used the velocities at the center of the room were increased somewhat when the windows were opened wide instead of only half way. Since the dry-bulb temperatures were not the same the Kata cooling effects are not comparable. Since the first story hall acted as a duct to convey the air from the first story, the velocity in the hall was considerably higher than that in the first and second story rooms.

Comparing the averages for the first and second stories in *Series 5* with those in *Series 7* and *8* it may be noted that there was some tendency for the basement fan to cause greater disturbance of the air in the rooms than there was for the attic fan. The velocities determined by the Kata thermometer, excluding the lower hall which acted as a duct when the attic fan was used, were higher for the basement fan than for the attic fan. In the former case the air was delivered into the room as a jet from the register while in the latter it was drawn more uniformly into the room through the windows. Hence more disturbance would result in the former case than in the latter.

Comparing *Series 10* and *11* it is evident that with the windows opened on the second story only, the air movement in the second story rooms was increased from 2.9 ft per minute when no fan was used to 17.5 ft per minute when the attic fan was used. Also this velocity was much greater than the 4.2 and 6.9 ft per minute obtained on the second story when the attic fan was used and all windows on both stories opened. A study of the velocities at the open windows in the latter case proved that the air was being drawn into the first story windows at an average velocity of 57.9 ft per minute and into the second story windows at an average velocity of 46.4 ft per minute. This indicated that when the attic fan was used in connection with both stories there was no tendency for the air to short-circuit through the second story windows at the expense of the first story, but, on the contrary, the suction resulting from the chimney action of the house was greater on the first floor than on the

Table 2—Results of Observations with a Kata-Thermometer

Series	Date 1933	Time of Test	Operating Notes	Air Temperature (Average) Deg Fahr				Air Velocity, FPM Dry Kata		
				First Story		Second Story				
				D. B.	W. B.	D. B.	W. B.	First Story Rooms	First Story Hall	Second Story Rooms
1	2	3	4	5	6	7	8	9	10	11
Still Air	6–24	2–4 p.m.	House closed up; No fan	79.2	67.9	82.0	68.5	4.3	4.6	3.0
2	8–22	7–9 p.m.	Natural ventilation; Maximum effect	75.5	63.4	77.8	64.3	3.2	3.7	2.8
4	6–24	4–5 p.m.	Recirculation of house air. House closed	79.6	68.4	81.5	69.1	19.4	—	6.6
5	6–26	7–9 p.m.	Basement fan maximum circulation	81.2	73.3	82.2	73.7	16.7	5.2	10.9
7	7–17	7–9 p.m.	Attic fan. All windows open halfway	74.9	61.3	74.2	61.0	12.2	25.8	4.2
8	7–30	7–9 p.m.	Attic fan. All windows open wide	83.1	71.5	83.9	71.7	19.2	30.7	6.9
10	9–2	8–9 p.m.	Attic fan. 2nd story windows open only	72.5	67.9	71.7	68.9	—	4.9	17.5
11	9–18	7–8 p.m.	Natural ventilation. 2nd story windows open only	73.0	63.6	74.9	63.0	—	3.9	2.9

Table 2 (Continued)

Series	Heat Loss, H, Btu per Sq Ft per Hr						Weather and Wind Conditions
	Dry Kata			Wet Kata			
	First Story Rooms	First Story Hall	Second Story Rooms	First Story Rooms	First Story Hall	Second Story Rooms	
	12	13	14	15	16	17	18
Still Air	35.5	36.1	28.7	133	143	118	Clear. Very hot; Max. = 96 F. West—13 mph
2	42.6	49.6	37.6	167	184	158	Cloudless skies. Cooling slowly; Temp. = 74 F. Practically calm. NE-4
4	40.9	—	32.6	161	—	138	Same as (a)
5	39.3	33.5	33.3	141	119	135	Partly cloudy. Wind SW-2
7	48.8	56.3	44.9	178	232	168	Almost cloudless. West wind mild
8	29.8	39.4	27.4	152	182	137	Almost cloudless. Calm. SW-3
10	—	48.9	59.8	—	143	174	Very humid. Temp. = 70 F. Calm
11	—	46.6	42.2	—	162	160	Cloudless. Outdoor Temp. = 71 F. Calm

Notes: Columns 5 to 8 inclusive, for dry-bulb and wet-bulb temperatures, are the average of 4 readings in each case.
Columns 9, 12, and 15 are the average of Kitchen, Dining Room, and Living Room.
Columns 10, 13, and 16 are the values for first story hall only.
Columns 11, 14, and 17 are the average of E. Bedroom, S. W. Bedroom, N. W. Bedroom, and Bathroom.

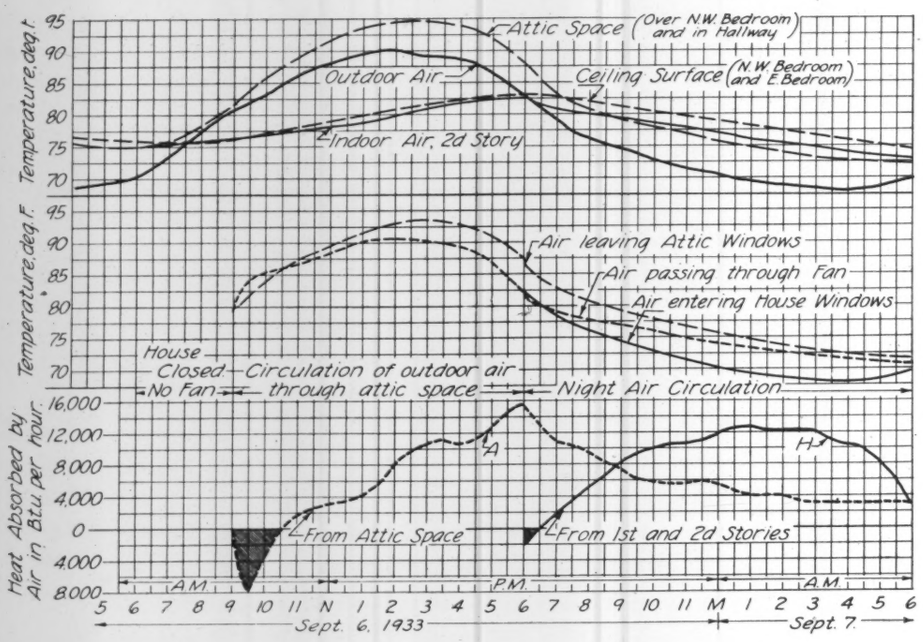

Fig. 8—Temperature cycle obtained with attic fan operation (day and night)

second and adding to the effect of the suction produced by the fan caused a greater flow of air into the first story windows than into the second.

A study was made to determine whether any advantage resulted from recirculating the air in the house by means of the basement fan while the house was closed during the daytime. These results are shown in Table 2, for still air and for *Series 4*, under date of June 24. When no recirculation occurred the air velocities at the center of the rooms were 4.3 and 3.0 ft per minute on the first and second stories respectively. The corresponding dry and wet Kata cooling effects were 35.5 and 28.7, and 133 and 118 Btu per sq ft per hr. These cooling effects were below the threshold for comfort. Immediately after making these observations the basement fan was started in order to recirculate the air. The velocity at the center of the rooms was increased to 19.4 and 6.6 ft per minute on first and second stories respectively and the corresponding dry and wet Kata cooling effects were increased to 40.9 and 32.6, and 161 and 138. The latter are very close to, or just above the threshold for comfort. Hence, while the effect was not very marked, some advantage resulted from recirculating approximately 1482 cu ft of air per minute, and, in border-line cases, this procedure might convert an uncomfortable atmosphere into one that is just comfortable.

A few tests, designated as *Series 12*, were run with the attic ventilated during the day by means of the attic fan instead of by natural ventilation through the windows. The temperature of the air in the attic together with the temperature of the surface of the ceiling and the air in the rooms of the second story for a characteristic day, are shown in Fig. 8. The temperatures of the air entering the fan and leaving the attic windows are also shown in this figure. These temperatures taken in connection with the volume of air delivered by the fan afforded a means of calculating the heat absorbed either from the attic or second story alone, or from both.

Considering the attic alone, during the day the air from outdoors entered the fan through the duct shown in Fig. 3 and was forced out through the windows. Thus the temperature rise was representative of the heat absorbed from the attic. A comparison of the power required by the fan motor for day and night operation indicated that no appreciable reduction in fan capacity was caused by the duct arrangement used during the day. Hence the full fan capacity of 3980 cfm was used in the calculations for curve *A* shown in Fig. 8. This curve gives the heat absorbed from the attic and shows a maximum rate of 15,600 Btu per hr, or the equivalent of 1.3 tons of refrigeration. However, a comparison of the results from two similar days, one with the fan in operation and one without, showed no appreciable lowering of the temperature of the air in the attic resulting from the use of the fan, and no appreciable difference in either the temperature of the surface of the ceiling or of the air on the second story for the two cases. The temperature of the air in the attic was measured at two points, approximately 4 ft above the floor. Hence it is probable that the temperature of the air in the peak of the roof and near the attic ceilings when no fan was used was much warmer than the air nearer the floor where the measurements were made. This formed a stationary pool of hot air above the level of the windows that served to reduce the heat transmission through the roof and to insulate the air nearer the floor. When the fan was used this pool was swept out and the movement of the air over the upper surfaces increased the heat transmission. Thus a large quantity of heat was removed and carried out by the air going through the windows, but the greater part of this represented heat that did not penetrate the lower stratum of air when the fan was not used. If this were the case, the measured temperature of the air near the floor would remain about the same whether the fan was or was not used. Thus the heat transmitted through the floor would remain about constant for the two cases and no change would occur in the temperature of the surface of the ceiling or of the air on the second story.

Thus, while the fan apparently removed a large quantity of heat from the attic during the day, no appreciable improvement in conditions on the second story resulted as compared with conditions existing when the attic was ventilated by means of open windows alone. More refined methods of testing might have indicated a slight difference, but if the difference was sufficiently small to demand more refined testing methods, the cost of operating the attic fan during the day could not be justified under the conditions existing at the Research Residence. It is possible that in a poorly ventilated attic, with no windows, or with small windows in positions not adapted to cross ventilation, the use of an attic fan during the day could be entirely justified.

The rate at which heat was removed from the first and second stories by the operation of the attic fan at night is shown by the curve *H* in Fig. 8. In this case the air was drawn into the windows from outdoors and all of the air passing through the house was delivered by the fan. Hence the difference in temperature between the air entering the fan and that outdoors was representative of the heat absorbed from the first and second stories. It may be noted that this heat amounted to approximately 12,000 Btu per hr or the equivalent of one ton of refrigeration, over a period of about 3 hr. Since approximately the same amount of heat loss would occur by conduction to the outdoors through the exposed walls, irrespective of whether night air was or was not circulated, the amount of heat represented by curve *H* represents in some measure the gain resulting from the circulation of air from outdoors at night. Owing to the presence of cross currents when full natural ventilation without the fan was used it was not possible to measure the actual heat absorbed in this case. However, the evidence presented in Fig. 6 indicates that very nearly as much heat was removed by the full open window ventilation in *Series 2* as that removed by the attic fan in *Series 7* and *8*. The portion of the curve *A* corresponding to curve *H* in Fig. 8, represents the additional heat removed at night from the attic alone. The whole of this amount can not be regarded as a gain for the next day, however, because due to the high heat transmission of the roof and to the fact that the windows in the attic were not closed during the day, the gain could not be conserved, as it was for the first and second stories on which the windows were closed at 6 a.m.

Effect of Methods of Night Operation on Conditions Next Day

Following a given method of night operation, the maximum temperature attained the next day after the windows have been closed at 6 a.m., depends upon the indoor temperature attained at 6 a.m. and the subsequent rise in outdoor temperature. As indicated by Fig. 5 this indoor temperature at 6 a.m. was the same as the minimum temperature attained indoors. Hence, it was determined by the night history, or the temperature drop shown in Fig. 6 corresponding to the particular method of night operation under consideration. The difference between the minimum outdoor temperature and the indoor temperature at 6 a.m. may be represented by, *C*, shown in the diagram in Fig. 9. The observed data from all of the tests not involving artificial cooling have been classified under four arbitrary values of the temperature difference, *C*, and the results have been plotted in Fig. 9, giving the relation between the rise in indoor temperature and that in outdoor temperature for the different values of *C*.

If the temperature corresponding to the crossing point of the indoor and outdoor temperature curves in the early evening hours is known for a given day, and the subsequent minimum outdoor temperature is obtained from the weather reports, both the indoor temperature drop and the difference, *C*, can be evaluated from the temperature drop curve in Fig. 6 corresponding to the particular method of night operation. The indoor temperature at 6 a.m. can then be found by subtracting the indoor drop from the temperature at the crossing point. By the aid of these data and the rise in outdoor temperature, *A* in Fig. 9, the rise in indoor temperature and the maximum indoor temperature attained in the house next day can be calculated. If some relation could be shown between the temperature at the crossing point and the minimum outdoor temperature following it, or the drop from the crossing point to the minimum outdoor temperature, then, for a given method of night operation, the probable maximum temperature attained in the house next day could be predicted for various combina-

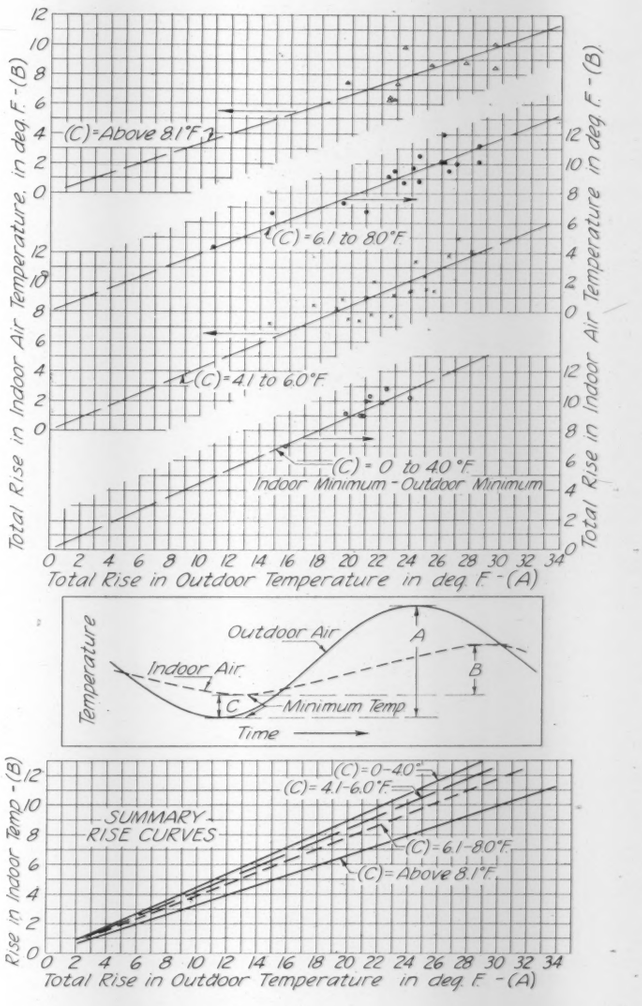

Fig. 9—Temperature rise curves

tions of outdoor minimums and succeeding outdoor maximums obtained from weather reports.

The relation between the temperature at the crossing point and the minimum outdoor temperature obtained from the observed data is shown in Fig. 10. Lines representing equal temperature drops from the temperature at the crossing point to the minimum outdoor temperature have been added. From the spread of points in Fig. 10, it may be observed that a number of different crossing point temperatures may exist for any given minimum outdoor temperature. Under these circumstances, for a given series of tests, in which the temperature of the crossing point is known from the test data, the solution for the maximum indoor temperature for the next day is obvious and simple. The difficulty in applying the curves to the prediction of the maximum house temperature in general, when no test is available but when the method of operation is given and the minimum and maximum outdoor temperatures are known from the weather reports, lies in the fact that, while all of the other factors are known or determinable from the curves, the temperature at the crossing point is a casual factor depending on the previous history of the house and the weather. It may be noted from Fig. 10, however, that over the whole range of observed weather conditions, the temperature drops from the crossing point to the minimum outdoor temperature, with few exceptions, were above 10 F and did not exceed 18 F. Hence, it is possible to establish upper limits for the maximum indoor temperature, above which this temperature would not rise with given combinations of maximum and minimum outdoor temperatures.

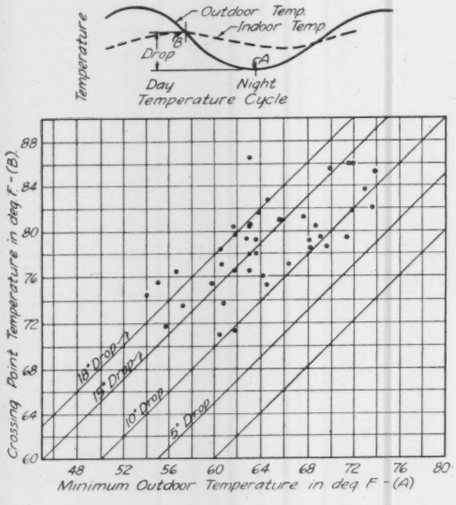

Fig. 10—Normal range of crossing temperature corresponding to minimum outdoor temperature. (Research Residence data, summer of 1933)

Assuming 18 F and 15 F drops, from Fig. 10, as characteristic of the most severe and of average weather respectively, the curves in Fig. 11 have been drawn representing maximum probable indoor temperatures resulting from various combinations of minimum and maximum outdoor temperatures occurring in connection with the most and least favorable methods of night operation. These may be used to predict the probable maximum indoor temperature from the weather reports of a given summer season.

Experience at the Research Residence seemed to indicate that approximately 82 F dry-bulb was a critical temperature from the standpoint of comfort. Without artificial cooling, and with the usual indoor relative humidity of from 50 to 60 per cent, conditions were reasonably comfortable if the indoor temperature did not exceed 81 F. This was equivalent to an effective temperature of between 74 and 75.5 F. Hence 81 F dry-bulb was accepted as the upper limit for comfort without cooling, and, for the cooling tests, the cooling plant was started when the indoor temperature reached 81 F. Under these conditions, owing to the reduction in indoor relative humidity when the cooling plant was in operation, the effective temperature remained somewhat below the 75 F indicated as the upper limit on the comfort chart.

Fig. 12 shows the various combinations of maximum and minimum outdoor temperature occurring at Urbana, Illinois, during the past seven summers. Practically all of the plotted data could be included between two lines representing upper and lower limits. From these curves

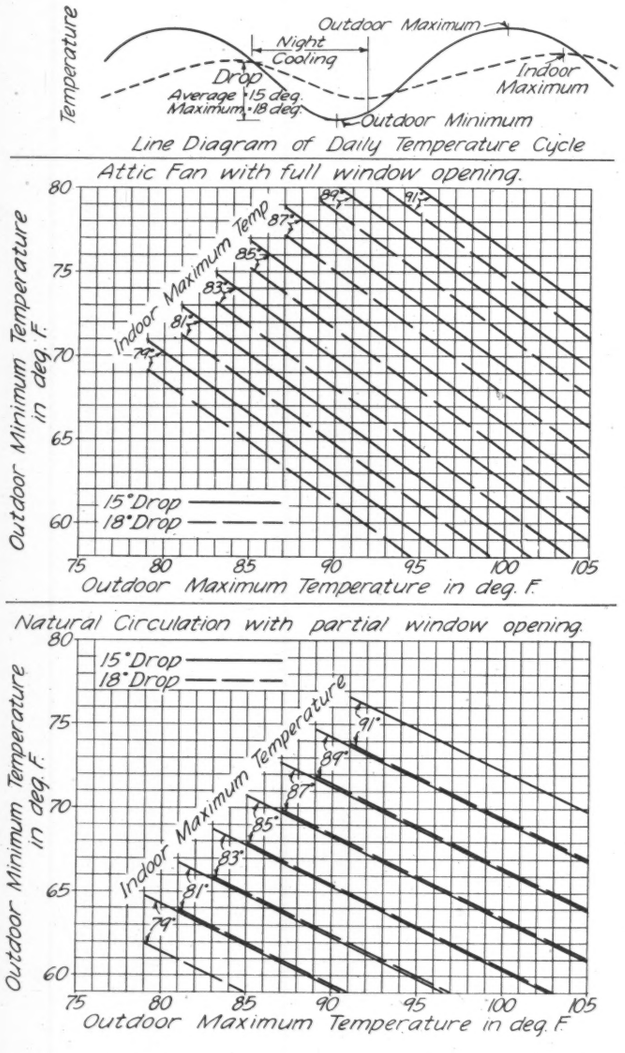

Fig. 11—Calculated maximum indoor air temperatures (Research Residence data, summer of 1933)

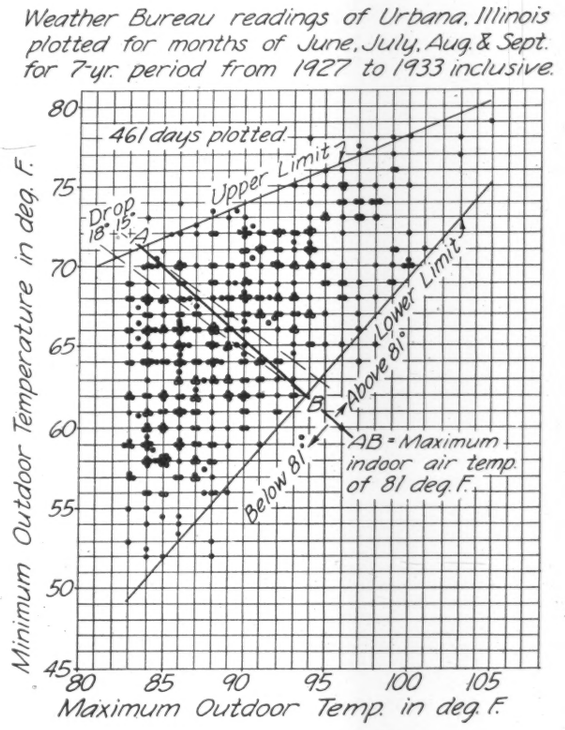

Fig. 12—Combinations of outdoor maximum and minimum temperatures in Urbana, Illinois

it may be observed that with a maximum outdoor temperature of 100 F the preceding minimum would not have exceeded 78 F. Judging from the points shown in Fig. 10, with this minimum outdoor temperature, the greatest drop from the crossing point to the minimum would be of the order of 12 F and certainly would not exceed 15 F. Hence for a day on which the maximum outdoor temperature was 100 F, with 78 F minimum outdoor temperature the night preceding and a 15 F drop in temperature from the crossing point to the minimum outdoor, a maximum indoor temperature not to exceed 92 F would be expected if the attic fan had been operated during the night. On the other hand if the house was operated on natural ventilation with partly open windows as in *Series 1*, an indoor temperature of 94.5 might be obtained. During one season comparatively few 100 F days would occur. There might be a considerable number of 95 F days, however. In this case, Fig. 12 indicates a possibility of a minimum outdoor temperature of 76 F and Fig. 10 of a 15 F temperature drop. These conditions would result in a maximum indoor temperature of 88.5 F succeeding a night of operation with the attic fan, and of 92 F for natural ventilation with partly open windows. Both of these indoor maximum temperatures are considerably above the 81 F representing the limit for comfort.

It is of some interest to consider the number of days that the maximum indoor temperature might have exceeded 81 F if the attic fan had been operated at night over the whole period of a season. Assuming from the evidence of Fig. 10 that 15 F and 18 F temperature drops represented limiting conditions for outdoor minimum temperatures above and below 68 F respectively, and obtaining from Fig. 11 the maximum indoor temperature for the actual maximum and minimum outdoor temperatures shown by the weather reports for each day in the summers of 1932 and 1933, it was found that there would have been 37 days in 1932 and 47 days in 1933 on which the maximum indoor temperature might have exceeded 81 F. This, of course, represents the upper limit and it is possible, since Fig. 10 shows that about 1/3 of the total number of observed points were below the 15-deg drop line, that actual operation might have resulted in approximately 25 and 32 days.

The 15 F and 18 F temperature drop lines representing indoor maximum temperature of 81 F have been transferred from Fig. 11 and shown in Fig. 12. Since the 15 F drop line is the most probable upper limit for outdoor minimum temperatures above 68 F and the 18 F for outdoor minimum temperatures below 68 F, the line *AB* represents a limit line above and to the right of which any combinations of outdoor maximum and minimum temperatures may certainly be expected to result in indoor maximum temperatures exceeding 81 F, and below and to the left of which represents such combinations resulting in maximum indoor temperatures not exceeding 81 F. From the points of intersection, *A* and *B*, it is evident that the maximum indoor temperature will always exceed 81 F if the outdoor maximum reaches 94 F, and may do so if the outdoor maximum rises above 84 F. Hence it is probable that night operation with a fan, even under the most favorable conditions, can not be depended upon to result in comfort over the whole of a summer season in a climate similar to that of Urbana, Illinois, unless supplemented part of the time by some form of artificial cooling. It can be used, however, to alleviate conditions even in the most severe weather, and in this respect may prove satisfactory to a considerable number of householders to whom the cost of a cooling plant might be prohibitive.

Circulation of Outdoor Air at Night as a Supplement to Ice Cooling

Only the three most favorable methods of night operation involving the use of the basement and attic fans, and full natural ventilation, were used to supplement ice cooling during the day. Fig. 13 shows temperature and indoor relative humidity curves for somewhat similar days and for two characteristic conditions in the operation of the cooling plant. The test of June 30 illustrates a case in which it was necessary to increase the rate of ice meltage and for which the 700 lb allotment was all melted before the outdoor temperature dropped 3 F below the indoor temperature, thus permitting the windows to be opened. In the case of all of the cooling tests the windows were not opened at any stated time, but the time was determined by the rate of decrease in the outdoor temperature. Only a few days similar to June 30 were encountered for which it would have been necessary to increase the meltage to somewhat more than 700 lb in order to maintain the indoor temperature below 82 F. In these cases the sacrifice in comfort was slight because the indoor relative humidity did not increase rapidly after stopping the ice meltage and the period before the windows were opened was comparatively short. The remaining tests shown in Fig. 13 illustrate cases in which the 700 lb of ice were more than suffi-

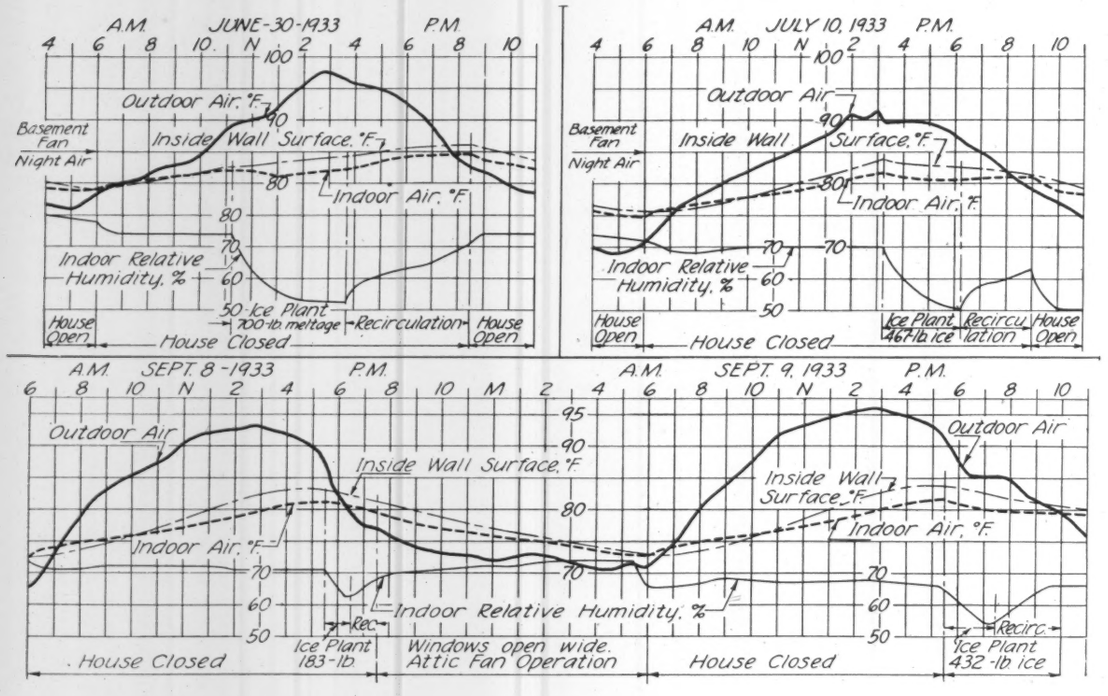

Fig. 13—Daily temperature cycles showing periods of operation of cooling plant

cient to maintain 81 F until the outdoor temperature was 3 F below that indoors.

The four tests shown in Fig. 13 prove that the amount of ice used was dependent both on the maximum temperature attained during the day and on the history of the preceding night. The tests of September 8 and 9 indicate that as a hot wave progressed and the maximum and minimum outdoor temperatures increased from day to day, the ice required increased because the cooling plant either had to be started earlier, or had to be operated longer before the outdoor temperature dropped 3 F below the indoor. The latter case is illustrated by the test of September 9 for which the outdoor temperature did not decrease as rapidly as it did on September 8. No cooling was required on September 7, although the maximum outdoor temperature was 91 F, which was comparable with July 10, and very little cooling was required on September 8 when the maximum outdoor temperature rose to 93 F. July 10 was preceded by a hot day during the night of which the minimum outdoor temperature was 69 F as compared with 67.5 F attained in the early morning hours of September 8. Hence the minimum indoor temperature was reduced to only 75 F to start the day of July 10 as compared with 72.5 F to start the day of September 8. Again on September 9, the minimum indoor temperature was reduced to 72.5 F in the early morning hours, and September 9, for which the maximum outdoor temperature reached 96 F, required about the same amount of ice as July 10, for which the maximum was 90 F.

A few tests, *Series 9*, with a room cooling unit in the living room proved that, with outdoor temperatures as high as 93 F, the temperature in the living room, lower hall, and dining room could be maintained at from 77 to 80 F. The temperature in the kitchen rose to 82 F but conditions were not particularly uncomfortable because the relative humidity maintained in the kitchen was the same as that in the other first story rooms. The relative humidity was reduced from a value of about 70 per cent to one of about 55 per cent. The unit produced no noticeable effect on the conditions on the second story.

In the case previously discussed, where no cooling was employed, the temperature corresponding to the crossing point of the indoor and outdoor temperature curves was a more or less casual factor, and the prediction of the maximum indoor temperature was confined to certain limiting values. In the case where the cooling plant is to be used consistently throughout the season, however, and the plant is started whenever the indoor temperature rises to 81 F, the temperature at the crossing point could usually be maintained at approximately 80 F. Hence, for a given method of operation at night, the curves in Figs. 6 and 9 used in connection with the minimum and maximum outdoor temperatures obtained from the weather reports for a given season afford a comparatively certain means of predicting the number of days on which the indoor temperature would reach 81 F and necessitate starting the cooling plant. If the ice meltage is limited to 700 lb a day and it is assumed that the 700 lb are always melted, then the product of 700 and the number of days requiring the use of the cooling plant represents the maximum limit of the amount of ice required per season. It is true that a few days were observed for which somewhat more than 700 lb of ice would have been required to maintain the indoor temperature at 81 F, but these days were more than offset by the ones not requiring the entire 700 lb. Hence, the amount of ice obtained by the method outlined would be the maximum.

On the assumption that the attic fan is used at night and the crossing point temperature is limited to 80 F, if an outdoor minimum temperature of 68 F is observed the

Table 3—Ice Requirements for Summers of 1932 and 1933

Series No.	Method of Operation at Night	Summer of 1932						Summer of 1933					
		Estimated No. of Days Requiring Cooling[b]					Ice Requirement Tons[a]	Estimated No. of Days Requiring Cooling[b]					Ice Requirement Tons
		June	July	Aug.	Sept.	Total		June	July	Aug.	Sept.	Total	
1	Natural ventilation. 8 windows partly open at 9 p. m.	21	24	18	2	65	23	25	24	12	12	73	26
3	Basement fan. 8 windows partly open at 9 p. m.	11	18	11	0	40	14	21	18	6	8	53	19
2	Natural ventilation. All windows open at 6 p. m.	9	17	8	0	34	12	20	15	3	6	44	15
7 and 8	Attic fan. All windows open at 6 p. m.	7	15	7	0	29	10	19	14	3	6	42	15

[a] Based on an ice consumption of 700 lb per day. [b] Based on indoor temperature exceeding 81 F at some time during the day.

indoor temperature drop of 8.1 F may be obtained from Fig. 6. This represents an indoor minimum, or temperature at 6 a.m. of 71.9 F. The temperature difference, *C*, shown in Fig. 9, would then be 3.9 F. If the outdoor temperature attained a maximum of 95 F the next day, the outdoor rise would be 27.0 F, and the indoor rise corresponding to a value of 3.9 F for *C* would be 12.0 F. Hence, the indoor temperature would rise to 83.9 F if no cooling were employed, indicating that the cooling plant would have to be started. By following this procedure for all of the recorded outdoor maximum and minimum temperatures for the summer the number of days requiring cooling and the maximum amount of ice required for the season may be obtained. This procedure has been followed for four different methods of night operation for the seasons of 1932 and 1933, and the summary is given in Table 3. Neither season would have required any cooling in the month of May.

During the summer of 1932, which included 1538 degree-hours above 85 F, 43 tons of ice were required under the system of operation followed for that summer. It is of considerable interest to note that if advantage had been taken of the possibility of circulating night air and an attic fan had been used under conditions corresponding to those for *Series 7* and *8*, the probable ice requirement would have been only 10 tons. With natural ventilation with all windows open the requirement would have been 12 tons, and with the basement fan with 8 windows partly open it would have been 14 tons. Even with the least favorable method of night operation the requirement would have been only 23 tons. The summer of 1933 included 2310 degree-hours above 85 F, and, as indicated in Table 3, the ice requirements would have been somewhat greater than those for the summer of 1932. However, the table presents concrete evidence that even the least favorable method of circulating the cool air from outdoors at night, when used to supplement some form of artificial cooling during the day, has merit as a means of reducing the cost of summer cooling to an amount that may not be prohibitive for the average householder.

Conclusions

The following conclusions may be drawn as applying to the Research Residence and the conditions under which the tests were conducted:

1. The circulation of air from the outdoors at night, when used as a supplement to artificial cooling during the day, has considerable merit in reducing the seasonal cooling load that would otherwise be required.
2. The circulation of air from the outdoors at night may make the use of artificial cooling unnecessary for a considerable portion of the summer season.
3. If the best means of circulating air from the outdoors at night had been used at the Research Residence during the summer of 1932 the ice meltage could probably have been reduced from the 43 tons actually used to an amount of the order of 10 tons.
4. The practice of partly opening a few windows at night is not very effective as a means of circulating air from the outdoors.
5. The use of a fan in a forced air heating system to circulate from 6 to 9 air changes per hour from the outdoors at night is much more effective than opening a few windows even when the same amount of window opening is retained for the two cases.
6. The use of a fan in a forced air heating system to circulate 9 air changes per hour is more effective if all of the windows and the attic door or hatchway is opened than if only a few windows are opened.
7. The most effective method of circulating air from the outdoors at night is to open all of the windows and to use an attic fan drawing the equivalent of approximately 17 air changes per hour into the windows of the first and second stories and discharging it into the attic to escape from the attic windows.
8. In the case of a two story house similar to the Research Residence having an ample attic with dormer windows and large attic door, opening all of the windows and the attic door is nearly as effective for circulating air from the outdoors at night as the use of an attic fan producing approximately 17 air changes per hour.
9. There is some advantage in opening the windows at 6 p. m. rather than at 9 p. m. even if the outdoor temperature is slightly higher than the indoor temperature at 6 p. m.

Codes

On Tuesday, November 21, an organization meeting of the Sectional Committee was held at the Engineering Societies Building for *A. S. A.* Project Z-5, Ventilation Code, sponsored by the American Society of Heating and Ventilating Engineers. W. H. Driscoll was elected chairman and the committee discussed the scope of the project and the procedure for carrying work forward.

Project Z-9, a Safety Code for Exhaust Systems, to be developed under *A. S. A.* procedure has been sponsored by the *International Association of Industrial Accident Boards and Commissions* and an organization meeting for the Sectional Committee was held in New York, November 22. The Society's representative in attendance was William M. Wallace, II.

At a conference of engineering societies representatives held in the headquarters of the *A. S. C. E.* in New York, November 24, Chairman C. L. Proctor outlined the progress made toward adoption of the Basic Code for the Construction Industry and the Code of Fair Competition for the Professional Engineers Division. The A. S. H. V. E. was represented by John G. Eadie and A. V. Hutchinson, Secretary.

Carbon Monoxide Surveys of Two Garages

By **A. H. Sluss*,** *(NON-MEMBER)* **E. K. Campbell** *(MEMBER)* **and Louis M. Farber** †† *(NON-MEMBER)*

DURING 1932 and 1933 co-operative studies on the minimum heating requirements of garages, with provision for the safe dilution of the carbon monoxide, have been conducted at Lawrence, Kan., and Kansas City, Mo., by the Kansas City Chapter of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS and the University of Kansas, in co-operation with the Research Laboratory of the A. S. H. V. E., and under the auspices of the Technical Advisory Committee on Ventilation of Garages and Bus Terminals.

Tests at Lawrence

The tests at Lawrence, Kan., were conducted in the Davis-Childs Chevrolet Garage, a single story building facing west with its south and east walls exposed. The building was 18 ft high, and was divided, as shown in Fig. 1, into a shop and a salesroom and office. Fig. 1 also shows the locations of the sampling stations.

Test Conditions and Results

Test L-1 was made February 29, 1932, under regular operating conditions, with doors, windows, and roof ventilators open, and with engine testing and general repair work being carried on. No carbon monoxide was found during this test.

Test L-2 was conducted under ordinary operating conditions on March 5, 1932, with doors and windows closed and with no special provision for ventilation. Engine testing and general repair work were being done at the time of the ventilation test, the results of which are shown in Table 1. It was found that carbon monoxide, too concentrated to be safe, was fairly evenly distributed throughout the shop and salesroom.

Tests L-3, L-4, L-5, and L-6 were conducted March 13, 1932, under special conditions to study natural ventilation. The results of these tests, shown in Table 2, indicate: (1) The results of tests L-2 and L-3 show that in garages with no mechanical ventilation, carbon monoxide tends to be uniformly distributed except where it is generated and in unswept portions of the garage; (2) When using roof ventilators, with no provision for admitting air, the carbon monoxide concentration was not reduced; (3) Under the same conditions, but with provision for allowing unheated air to enter, the carbon monoxide content was rapidly lowered, but the temperatures were reduced below the comfort range; (4) With three cars idling and with the roof ventilators and the side and rear doors open, the carbon monoxide concentration was reduced to a safe value.

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Tests at Kansas City

The tests at Kansas City were conducted in the garage of the United Motors Service Co., a two story building facing west with the north and east sides exposed. Only the first story, 14 ft high, was under observation. As shown in Fig. 2, an electric shop was located in a recess in its southeast corner, surrounded by solid walls on three sides, but with no intervening wall between it and the garage. The floor of this section was three feet higher than the main floor. Engine testing was ordinarily conducted on the main floor just north of the electric shop.

Since there was little air movement in the shop and its breathing line was three feet higher than that in the main room, carbon monoxide tended to concentrate in this space. In order to blow it out, a centrifugal fan type unit heater was installed as shown on the drawing, at 5, with a duct carrying outside air into the electric shop, the main discharge being horizontal toward the back wall. A study of the air movement resulting from this single opening showed that when the air was heated it did not stay at the floor long enough to accomplish its purpose, but rose and passed out near the ceiling. A small extension of the duct was therefore made to blow directly toward the floor. The total volume of air moved by the unit, on anemometer test, was 3600 cu ft per minute, which was a change of air for the entire electric shop about once every four minutes. Provision was made so air could be either recirculated or taken from the outside. During all of the tests, outside air was used. Owing to the mild winter, it was very difficult to find a cold day when the doors were kept closed and when business was heavy.

Table 1—Test L-2—General Survey of Carbon Monoxide Concentration in Lawrence Garage

Date, March 5, 1932; time, 3 P. M. to 4 P. M.; outside temperature, 26 F; inside temperature at 5 ft level, 65 F; wind, 5 mph, N. W.; all garage ventilators and windows closed; activity in garage, general repairing; car movement in and out estimated at 4 cars per hour.

	CO CONCENTRATION—PARTS PER 10,000										
SAMPLING STATIONS AND LOCATIONS / ELEVATION ABOVE FLOOR, FT.	A EAST CENTER SHOP	B WEST CENTER SHOP	C N. W. CORNER SHOP	D N. E. CORNER SHOP	E S. E. CORNER SHOP	F S. W. CORNER SHOP	G CENTER SALES ROOM	H N. W. CORNER OFFICE	I WEST CENTER OFFICE	J S. W. CORNER OFFICE	K S. E. CORNER OFFICE
1	0.8	1.8	3.2	1.8	1.3	0.8	1.8	0.0	.....	1.3	1.3
5	0.8	1.8	1.8	1.8	1.3	1.8	1.8	0.8	1.8	1.8	0.8
10	0.8	1.3	1.8	1.8	1.3	0.8	2.6	1.8	1.3	1.8	0.8
15	.....	.....	.....	.....	.....	.....	.....	1.8	1.8	1.8	.....
18	1.3	1.3	1.8	1.3	1.8	1.8	1.8	.....	.....	.....	.....
25	1.3	1.3	.....	.....	.....	.....	1.8	.....	.....	.....	.....

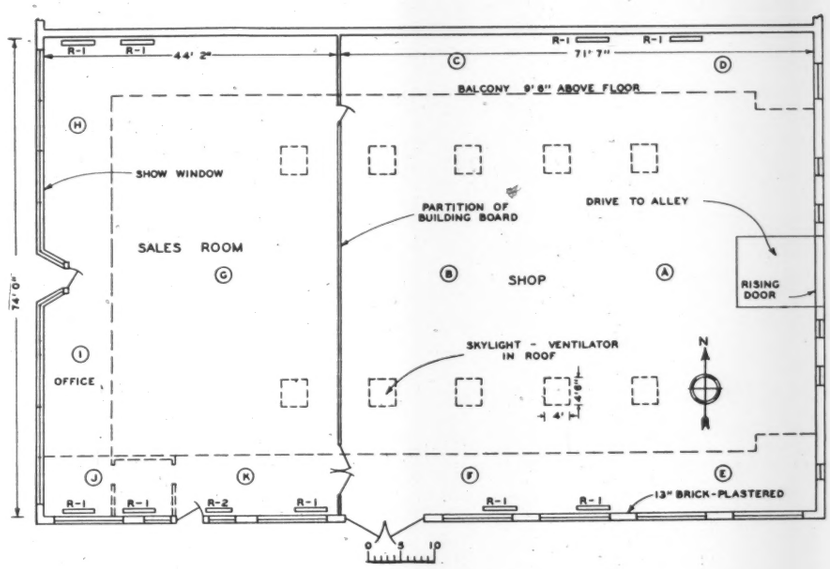

Fig. 1—Plan of Davis-Childs Garage, Lawrence, Kansas

Test Conditions and Results

Test KC-7 was conducted on February 15, 1933, with no special provision for ventilation. Business was light and did not involve engine testing except for a quarter hour at 2:15 p. m. The results of this test, shown in Table 3, indicate that on a day when the doors must be kept closed and when business is light, the carbon monoxide concentration is kept at safe levels by infiltration and by air which enters when the doors are opened for cars.

Tests KC-8, KC-9, and KC-10, were conducted March 11, 1933, to study the effect of the ventilating system on the distribution of carbon monoxide. Their results, given in Table 4, indicate that, taking the initial concentration and the interval between sampling into account, the system satisfactorily reduced the concentration of carbon monoxide in the electric shop and in the adjacent space. It was noticed that the air cleared first in the electric shop and that there was a movement of visible exhaust fumes into the main room. When the north windows were opened at the top to the same area as the air outlet of the ventilating system, the movement of the fumes was accelerated. The results of these tests indicate that the carbon monoxide concentration in a given space may be satisfactorily reduced by a ventilating system, but that definite provision must be made to remove the mixture which is driven away.

Reports of headaches began to come from the north side of the main room, where previously there had been no complaints, indicating a relatively higher concentration of carbon monoxide there because it was moved from the electric shop. It was found that the windows in the north side could be opened with no discomfort to the workmen, so that a draft diluted the carbon monox-

Table 2—Report of Tests L-3, L-4, L-5, and L-6. Surveys of Carbon Monoxide Concentration in Lawrence Garage when Using Roof Ventilators

Date, March 13, 1932; Outside Temperature, 35 F; Wind, N.N.W., 15 mph.

Test No.	L-3					L-4					L-5					L-6	
Time of Sampling	6:40-7:10 P.M.					8:05-8:20 P.M.					8:30-8:45 P.M.					8:53-9:00 P.M.	
Ventilation	No Ventilation					4 South and 1 Northeast Roof Ventilators Open from 7:15 P.M. to 8:20 P.M.					4 Roof Ventilators Open from 7:20 P.M. to 8:45 P.M. South Door Open from 8:22 P.M. to 8:45 P.M.					4 Roof Ventilators Open from 7:20 P.M. to 9:00 P.M. South Door Open from 8:22 P.M. to 9:00 P.M. East Door Open from 8:53 P.M. to 9:00 P.M.	
No. Cars Running	5					3					3					3	
	CO Conc. Parts per 10,000				Temp. F	CO Conc. Parts per 10,000				Temp. F	CO Conc. Parts per 10,000				Temp. F	CO Conc. Parts per 10,000	
Sampling Stations and Locations / Elevation Above Floor, Feet	B W. Center Shop	D N. E. Corner Shop	E S. E. Corner Shop	F S. W. Corner Shop		B W. Center Shop	D N. E. Corner Shop	E S. E. Corner Shop	F S. W. Corner Shop		B W. Center Shop	D N. E. Corner Shop	E S. E. Corner Shop	F S. W. Corner Shop		B W. Center Shop	D N. E. Corner Shop
1	0.8	1.3	1.3	1.8	61	1.8	0.8	0.8	0.8	53	0.8	0.8	0.8	0.0	37	.....	.....
5	0.8	0.8	0.8	1.3	62	2.6	1.8	1.8	2.6	53	0.8	1.3	0.8	0.0	40	.....	0.8
9	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.8	0.8	0.0	53	.....	.....
10	1.3	0.8	0.8	1.8	.....	2.6	2.6	1.8	2.6	55	1.3	.....	.....	.....	.....	0.0	.....
15	.....	1.3	1.3	1.3	.....	.....	1.8	1.8	1.1	.....	.....	.....	.....	.....	.....	.....	.....
18	1.3	.....	.....	.....	.....	1.1	.....	.....	.....	.....	1.3	.....	.....	.....	.....	0.8	.....
25	1.3	.....	.....	.....	64	0.8	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.0	.....

Table 3—Test KC-7

Time P. M.	Station	Height Above Floor Feet	Parts CO in 10,000 Air	Remarks
2:00	1	5	.....	Test spoiled
2:10	2	5	0 0	
2:13	5	5	0 0	
2:14	4	5	1 0	
2:15	3	5	0 2	
2:22	8	5	6 5	Cars running in front of electric shop
2:24	8	5	6 5	
2:26	8	½	1 6	
2:40	7	½	1 0	
2:40	7	5	1 0	
2:45	1	5	0 0	
2:45	1	1	1 0	
2:45	2	1	1 0	
2:48	2	5	1 0	
2:50	5	1	1 0	
2:50	5	5	1 0	
2:55	3	5	1 0	
2:55	3	1	1 0	
3:00	4	5	0 0	Small fan running on each side of sample
3:00	4	1	1 0	
3:05	11	5	0 0	
3:05	11	1	1 0	
3:10	9	5	1 0	Main door opened
3:10	9	1	0 0	

Table 4—Tests KC-8, KC-9, KC-10. Surveys of Carbon Monoxide Concentration in Kansas City Garage Using Mechanical Ventilation

Test No.	K C-8		K C-9		K C-10		
Time of Sampling	7:36-8:00 P.M.		8:15-9:14 P.M.		10:35-11:00 P.M.		
Ventilation	Fan Off Windows and Doors Closed		Fan Operating Windows and Doors Closed		Fan Operating Windows and Doors Closed		
Car Operation	Running		Running		Engines Stopped		
	CO Conc. Parts/10,000		CO Conc. Parts/10,000		CO Conc. Parts/10,000		
Elevation Above Floor, Ft.	1	5	1	5	1	5	12
Sampling Stations and Locations							
2. S. E. Shop	.....	4 3	.....	2 5	.....	0 0	.....
1. S. Center Shop	2 3	4 3	4 3	5 3	0 0	0 4	0 0
6. S. W. Shop	4 3	4 3	.....	3 4	.....	0 0	.....
5. N. E. Shop	.....	11 0	.....	4 3	.....	0 0	.....
3. N. W. Shop	.....	8 8	.....	3 3	.....	0 0	.....
7. S. E. Service	.....	10 0	.....	4 2	.....	0 0	.....
8. S. Center Service	.....	4 3	.....	4 2	.....	0 0	.....
9. S. W. Service	.....	4 3	.....	5 3	.....	0 0	.....
12. E. Center Service	3 3	6 5	5 3	5 3	.....	0 0	.....
10. N. E. Service	.....	1 8	.....	.....	.....	0 0	.....
11. N. W. Service	.....	6 5	.....	.....	.....	0 0	.....

*Shop floor is three feet above service floor.

ide concentration to the point where reports of headaches ceased.

Test KC-11 was conducted on March 20, 1933, to determine the carbon monoxide concentration when using the ventilating system with the windows closed (except as noted in the foregoing paragraph) and the doors closed except for cars to enter or leave. Business during this test was considered heavy by the management of the garage. The doors were opened an average of twenty times an hour; the average number of cars in the garage was fifteen; and the rate of change was about fifteen cars per hour. It was estimated that during the test one car was idling all the time and one car was moving half the time. The results of the analysis in Test KC-11 are shown in Table 5, and indicate that the carbon monoxide concentration in the entire space had been reduced to a satisfactory amount. The clerks in the small office reported headaches, and it was found that at the time of this test the carbon monoxide in the office was one part in 10,000. As the office was supplied with excess radiation, a small fan was installed to furnish it with the necessary amount of fresh air.

Table 5—Test KC-11

Time	Station	Height Above Floor, Ft.	Parts CO in 10,000 Air
8:55 A.M.	3	9	0 0
8:58	3	5	0 0
9:00	2	5	0 0
9:08	8	5	0 0
9:11	9	5	0 0
9:12	11	5	0 4
9:40	3	9	0 4
9:43	3	5	0 0
9:45	2	5	0 0
9:49	8	5	...
9:51	9	5	0 4
9:55	11	5	0 4
10:45	3	5	1 0
10:47	3	9	0 0
10:53	2	5	0 4
10:55	8	5	1 0
11:00	9	5	1 0
11:05	11	5	0 4
11:10	13	5	0 4
11:45	3	5	0 0
11:46	3	9	0 5
11:50	2	5	0 4
11:55	8	5	0 2
11:58	9	5	0 0
12:00	11	5	0 4
1:58 P.M.	11	5	0 2
1:59	9	5	0 2
2:00	8	5	0 2
2:02	3	5 & 3	0 4
2:03	2	5 & 3	0 0
Opened north windows 6 in. from top			
2:51	11	5	0 0
2:52	9	5	1 0
2:53	8	5	1 0
2:55	3	5 & 3	1 0
2:57	2	5 & 3	0 0
3:22	11	5	0 4
3:23	9	5	0 0
3:24	8	5	0 0
3:26	14	5	1 0
3:27	14	5	0 4
3:29	3	8	0 4
3:32	2	8	0 4
3:50	Outside		0 0

Conclusions

The results of these studies show, in general, that the requirement of human comfort causes the need for ventilation, therefore:

(1)—In most garages there is no carbon monoxide hazard, except in cold weather when it is necessary to close the doors and windows.

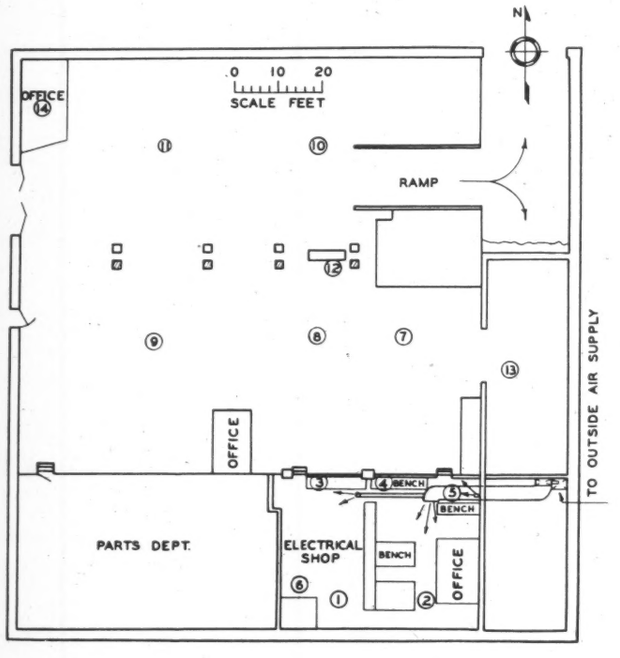

Fig. 2—Plan of United Motors Garage, Kansas City, Mo.

(2) Ventilation with unheated air is not feasible during cold weather.

(3)—Carbon monoxide concentration tended to increase in unswept portions of the room.

(4)—The amount of air necessary to eliminate the carbon monoxide hazard in a garage may be reduced from the theoretical volume, providing it is properly introduced into the unswept portions, thereby driving the mixture into the swept portion where it can be disposed of by infiltration.

(5)—The permissible reduction from the theoretical volume of 5000 cfm per idling car is in proportion to the volume of infiltration effectively utilized.

(6)—Outside air used to dilute CO and sweep otherwise dead corners and pockets, must be heated sufficiently to maintain comfort, and it was found that extra heat introduced with the outside air allowed a considerable increase in infiltration without increasing discomfort.

(7)—An interesting parallel is developing betweeen CO and gasoline fumes, in that, under many conditions, the formation of pockets supplies the hazard and for the solution of either problem, the ventilation system must be so designed as to break up pockets and utilize the natural infiltration as well as the directly supplied and heated outside air, for dilution in order to keep the costs within commercial limits

Acknowledgment

Acknowledgment is made of the cooperation of the following who have rendered valuable assistance in carrying on these studies: Davis Childs Chevrolet Co., Lawrence, Kan., United Motor Service Co., Kansas City Branch, Mr. Ward Cole, graduate student of Bio. Chemistry of the University of Kansas, and Mr. John G. Lewis, Kansas City (Member).

Annual Report of Pittsburgh Chapter

A summary of Pittsburgh Chapter meetings during the season of 1932-1933 has been prepared by the Secretary, J. L. Blackshaw:

October 17, 1932: At its October meeting, instead of a customary hotel banquet, the Pittsburgh Chapter ate a depression dinner of hot dogs, salad, cake, and coffee, served at small cost by the members. There were 37 members and guests present. After Chapter business was finished, Pres. R. B. Stanger presented the speaker of the evening, A. J. Nesbitt, Philadelphia, who gave an illustrated talk on tests he had conducted in a Philadelphia school room in collaboration with J. D. Cassell, Superintendent of Buildings of the Philadelphia Board of Education. Mr. Nesbitt described the principles of good heating and ventilation of school rooms and showed methods and results of his experimentation. He summed up his talk by listing six points as essentials of good classroom ventilation.

November 14, 1932: The regular November meeting was held in the assembly room of the Fort Pitt Hotel with 25 members and guests in attendance. At this meeting, the report of the Chapter Nominating Committee was received. M. A. Benson presented the speaker, W. S. Brotzman, associate meteorologist of the United States Weather Bureau in charge of the Pittsburgh Office, who gave an illustrated talk on the weather, which was greatly enjoyed by those present.

December 12, 1932: This was the annual meeting of the Chapter. Upon unanimous vote, the following officers were elected for 1933:

President—G. S. McEllroy.
Vice-President—P. A. Edwards.
Secretary—J. L. Blackshaw.
Treasurer—H. B. Orr.
Board of Governors—R. B. Stanger, Peter O'Neill, F. H. Hecht.

Instead of the usual talk, an informal round-table discussion filled out the evening. H. L. Moore, J. L. Blackshaw, V. W. Hunter, C. M. Humphreys, and E. C. Evans spoke on various phases of Society activity.

December 20, 1932: This was a special meeting called by the new officers of the Pittsburgh Chapter to discuss past and future Chapter policy concerning meetings, announcements, place of meetings, dues, membership, and funds. It was decided to discontinue meetings with dinners and to hold future meetings in the auditorium of the U. S. Bureau of Mines.

January 16, 1933: The regular January meeting was held in the auditorium of the U. S. Bureau of Mines. Thirty-eight members and guests were in attendance. Following Chapter business President G. S. McEllroy presented T. A. Novotney, who spoke on Concealed Radiators. In his talk, Mr. Novotney pointed out how valuable the A. S. H. V. E. Research Laboratory had been in moulding correct heating and ventilating practice.

February 13, 1933: Sixty members and guests attended the regular February meeting held in the U. S. Bureau of Mines. T. N. Adlam, formerly of England, addressed the meeting on Radiant Heating. He traced the history of the radiant method of heating from the time of the early Roman baths down to the present day. The talk was illustrated with slides and pictures, and the eupatheoscope and other mechanical devices were exhibited. Radiant heating was considered from engineering and physiological standpoints.

March 13, 1933: At this meeting in the U. S. Bureau of Mines, after regular Chapter business had been cared for, the members and guests in attendance enjoyed a talk by Dr. C. E. Skinner, former director of research for the Westinghouse Electric and Manufacturing Co. His talk was on Electrical Pioneering and was a review of the electrical industry, filled with anecdotes, and told by a man with a wealth of personal experience in the field who had grown up with commercial electrical developments.

April 12, 1933: The April meeting of the Pittsburgh Chapter was held in the auditorium of the U. S. Bureau of Mines. After a short business session, F. C. McIntosh presented the Chapter's guest and speaker, W. T. Jones, of Boston, president of the American Society of Heating and Ventilating Engineers, who spoke on The Status Quo of Engineering. President Jones gave a spirited and inspiring talk on the many phases of A. S. H. V. E. work and showed the relation existing between an engineering profession and that profession's society. He not only pointed out the many advantages gained through membership in an ethical society through its activities, publications, research work, meetings and other functions, but proved definitely that a member of the A. S. H. V. E. got more from the Society in its Transactions, Guide, and Journal alone than he paid for in dues, not to mention the personal contacts. President Jones lauded the Society for maintaining its own research laboratory, it being the only technical society to have one, and answered many questions concerning the Society which were put by the members in the course of an enthusiastic discussion.

May 8, 1933: The final monthly meeting of the season was held in the U. S. Bureau of Mines. After a business session, the audience enjoyed one of the most enthusiastic and good natured meetings yet had by the Chapter. Two two-man teams, J. E. McLean and P. A. Edwards on one side, and F. J. Firsching and T. F. Rockwell on the other, debated Hot Water vs. Steam for Heating. After the arguments, informal discussion was had by the audience.

NOMINATIONS FOR 1934

The Nominating Committee appointed to select candidates for Officers of the Society for the coming year, 1934, submits the following list of nominees:

For President:

C. V. HAYNES, Philadelphia, Pa.

For First Vice-President:

JOHN HOWATT, Chicago, Ill.

For Second Vice-President:

G. L. LARSON, Madison, Wis.

For Treasurer:

D. S. BOYDEN, Boston, Mass.

For Members of the Council:

Three-Year Term

E. H. GURNEY, Toronto, Ont.
W. A. RUSSELL, Kansas City, Mo.
O. W. OTT, Los Angeles, Calif.
M. C. BEMAN, Buffalo, N. Y.

One-Year Term

ALBERT BUENGER, St. Paul, Minn.

Respectfully submitted,

NOMINATING COMMITTEE,

W. R. EICHBERG, *Chairman;*
C. A. PICKETT, *Secretary.*

In accordance with the provisions of the Amended Constitution, as given, ballots containing the names of the above candidates will soon be sent to the membership for voting upon prior to the Annual Meeting in January.

Art. B-VIII—Section 10. The Nominating Committee shall consist of one (1) member eligible to vote designated by each Chapter, or his alternate also appointed by the Chapter. The Secretary of each Chapter shall certify to the Secretary of the Society on or before January first the names of the member and alternate selected.

The Committee shall meet at the Annual Meeting of the Society at the call of the Secretary of the Society and shall effect its own organization and elect its own Chairman. At the Semi-Annual Meeting of the Society, if possible, the Nominating Committee shall select the nominees for the ensuing year for the offices of President, First Vice-President, Second Vice-President, Treasurer, and four (4) members of the Council. In any event the names of the nominees shall be certified to the Secretary of the Society before September twentieth, with the written consent of each nominee to fill the office for which he has been selected and their names with the offices to which they have been nominated shall be published in the October issue of the JOURNAL.

Art. B-IX—Section 2. The Secretary shall prepare ballots with the names of all candidates and forward them to the members, eligible to vote, at least thirty (30) days before the date of the Annual Meeting.

Nominations for Members of Committee on Research

Although committees of the Society are usually appointed, in view of the great importance of the Committee on Research and the financial responsibility it would be called upon to assume, it has been made more representative of the entire membership of the Society by a process of *election*. The election is governed by the By-Laws for the election of officers, with the single exception that Members of the Committee on Research are nominated by the Council instead of by a Nominating Committee.

In accordance with the Regulations for the Government of the Research Laboratory, adopted at the January, 1919, Meeting, and amended January, 1933, the Council announces the nomination of the following members of the Committee for election to succeed those members whose present terms expire January, 1934:

Three-Year Term

C. A. BOOTH, Buffalo, N. Y.
E. K. CAMPBELL, Kansas City, Mo.
JOHN HOWATT, Chicago, Ill.
A. J. NESBITT, Philadelphia, Pa.
J. H. WALKER, Detroit, Mich.

The regulations governing the nomination and election of members of the Committee on Research are as follows:

ARTICLE II—ORGANIZATION

Section 1. *Committee on Research*—There shall be a standing committee known as the Committee on Research, consisting of fifteen (15) members each serving for three (3) years and five (5) retiring each year. The outgoing Chairman if serving in that capacity during the last year of his three (3) year term on the Committee shall without election become an additional member of the Committee on Research for one (1) year.

(a) The Council shall nominate previous to July first of each year five (5) members to fill the vacancies of those retiring at the next Annual Meeting.

(*b*) The nominations made by the Council shall be published in the October issue of the Society's Journal.

(*c*) Any ten (10) members of the Society eligible to vote may present to the Secretary over their signatures, the name of one (1) or more additional nominees for the Committee on Research, provided such name or names are presented at least sixty (60) days prior to the next Annual Meeting, and such additional nominations shall be placed on the ballot opposite the nominations made by the Council.

(*d*) The election shall otherwise conform to the regulations provided for the election of officers of the Society in the Constitution, By-Laws and Rules.

(*e*) Vacancies may be filled by the Council, such persons chosen by the Council to serve until a successor is elected at the next Annual Meeting.

New York to Entertain A. S. H. V. E.

Looking east on 42nd St.

THE A. S. H. V. E. will celebrate its 40th Anniversary by holding the Annual Meeting 1934 in New York at the Hotel Biltmore, February 5-8, when the New York Chapter will act as host and the entertainment program will be carried out by the Committee on Arrangements, of which Arthur Ritter is chairman. He will be assisted by the following committee chairmen: *Reception,* W. W. Timmis; *Banquet,* H. B. Hedges; *Ladies,* Charles S. Hoffman and Clyde R. Place; *Entertainment,* Alfred Engel; *Finance,* F. E. W. Beebe; and *Publicity,* R. B. Purdy.

All technical meetings will be held in the ballroom of the Hotel Biltmore and, with the exception of a special trip through Radio City, the main entertainment functions will be held in the hotel.

Ample time has been reserved by the Committee on Arrangements so that members can not only see the sights of New York, but also attend the Third International Heating and Ventilating Exposition, which will open February 5 and will continue until February 9 at Grand Central Palace.

Past Presidents of the Society will have their annual meeting upon the evening of February 6 and the gala entertainment function of the meeting will be held on Wednesday in the form of a banquet, entertainment and dance.

It is the local committee's plan that the 40th Annual Meeting of the Society will be remembered as one of the most enjoyable ever held.

The technical program is extensive and subjects have been grouped so that related topics will be presented at various sessions. Studies of solar radiation, hot water circulation, warm air heating system control, and a series of reports on conditioning homes where various types of heating, humidifying and cooling equipment are used will be outstanding contributions. A session will be devoted largely to a discussion of the medical viewpoint on air conditioning and will present a series of studies on hay fever, the effect of health rays, and the influence of atmosphere on health.

Investigation of boiler performance, electric heating, and description of a new research laboratory are important contributions that will be offered.

The local committee is planning some special diversions for ladies which will be of unusual interest. A special performance at Radio City and a bridge and tea are planned.

Members will receive additional announcements of the progress made in effecting the program and full directions regarding the use of reduced rate railroad certificates and complete information about hotel rates and reservations.

Pres. W. T. Jones, Boston, will open the 40th Annual Meeting on Monday afternoon, February 5, and technical sessions will be held each day. This meeting will be an interesting and educational one and every Society member is urged to attend.

The Heating and Ventilating Exposition

Divided into several broad classifications indicating the type of equipment, fuels, materials, and methods employed in heating, air-conditioning, and ventilating, the Third International Heating and Ventilating Exposition will reveal characteristic displays in Grand Central Palace, N. Y., February 5-9. This type of active display is being developed by practically all the exhibitors in view of the current trend toward making exposition exhibits attractive, informative, and interesting.

One exhibitor will show a glass model of a steam trap operating at five pounds pressure. By means of the glass construction, visitors will be able to see how the trap handles air and sludge, as well as condensate. Similarly featured will be an automatic air by-pass for the quick heating of units containing large volumes of air of interest to users of process equipment requiring large quantities of steam.

A boiler company will exhibit two steel heating boilers, one designed exclusively for oil burning, containing extra features for draft control and for domestic hot water supply; the other for larger residences and the smaller public and commercial buildings. Provision is made for refuse disposal and for an auxiliary grate for stand-by heating. In another exhibit the visitor will view a complete line of indirect water heaters, for summer and winter domestic hot water supply, designed to be connected to the heating boiler. These units can also be installed within the heating boiler itself, or in special headers or storage tanks ranging in capacity from 30 to 10,000 gallons. Contractors, handling oil burners, stokers, and gas fired equipment, engineers and architects, are classes to which this display will be of direct interest.

In contrast to the units themselves for heating, ventilating and air-conditioning, there is a host of auxiliary equipment which visitors to the Exposition will find rewarding. A brass company, whose slogan is "from mine to consumer" will feature metals rather than machines, but will relate them to the machines in the applications which they serve. Developed for specific engineering requirements, these metal products will be demonstrated in semi-finished and finished forms. There will be copper tubes tinned by a new process and extruded condenser tubes. Forming the background will be copper tubes for use with threadless fittings, copper pipe, red brass pipe, rolled sheet copper, and rods, wire, tubes, and castings. Air-

conditioning, gas, power engineering, and pressure-vessel specialists will be interested.

At another booth the visitor will come upon the latest type of automatic switches and controls for equipment used in heating, refrigerating, ventilating, and air-conditioning. Displayed also will be thermostats of many kinds, operating temperature and pressure controls; water valves, safety controls, dual controls, and relays. There will be a complete new line of oil-burner stack, safety, combustion controls. Based on an engineering experience of many years, some of these items will use old principles, others will reflect advanced principles of design, developed during the past two years.

Complete year-round, residential air-conditioning will be illustrated by one of the furnace companies. The same company will exhibit a line of gas fired furnaces. A radiator company will show a versatile line of unit heaters, unit coolers, blast heaters, and commercial heat-transfer units, along with copper convectors of both the cabinet and concealed types. This manufacturer of heat transfer equipment, will display examples of different types of complete units, also the heating elements and cooling coils.

In the field of hot water heating, one company will feature a flow control system and will call attention to water circulators, flow control valves, pressure reducing valves, pressure relief valves, and automatic temperature regulators. In the oil burner field a pioneer concern will show burners, meters and by-pass oil valves.

Of especial interest to heating and ventilating engineers because of the great variety of parts exhibited is the story of an appliance company to be told in terms of brass, bronze, aluminum and nickel. The fabricated specialties will include tubing, tube fabricating tools, tube couplings, valves, and associated equipment.

The line of air-conditioning registers and grilles will be extensive and varied. In addition to a convection heater, one company will exhibit a new air-conditioning register and a straight flow and volume control register.

Local Chapter Reports

Cleveland

October 26, 1933—The meeting was called to order by Pres. F. A. Kitchen at 8:15 p. m. in the Meeting Room of the *Cleveland Engineering Society* with 20 members and guests present.

The first business of the evening was the election of a Chapter secretary, to fill the vacancy resulting from R. H. Wehrle's transfer to Cincinnati. W. E. Stark, chairman of the Nominating Committee, proposed the name of M. B. Wright, who was unanimously elected secretary.

President Kitchen referred to a letter sent during September to each chapter member and discussed briefly the new plan for increasing membership in the national and local organizations.

Mr. Kitchen expressed his desire to see the activity of the Cleveland Chapter increase during the coming year and stated that, with this in mind, the Program Committee was endeavoring to obtain nationally known speakers for future meetings. It was announced that F. C. Houghten would in all probability be the speaker in November and members of the Chapter having specific questions relative to the work done at the Research Laboratory were requested to present them to President Kitchen, so that they might be forwarded to Mr. Houghten before the meeting.

Following the president's announcements, Philip Cohen of the Red Team was asked for a report.

Mr. Stark spoke of the Semi-Annual Meeting held in June at Detroit and touched on the high lights of the technical sessions and the meeting of the Committee on Nomenclature.

R. G. Davis, chairman of the Unemployment Committee, reported that the *T. M. A.* had been dissolved and that the problem of unemployment would be handled by the *Cleveland Engineering Society* in the future. He urged the chapter members to notify the society of any available positions that might come to their attention.

The report presented at the Semi-Annual Meeting by the Nominating Committee was discussed by President Kitchen.

W. H. Driscoll, New York, N. Y., a past president of the A. S. H. V. E., was then presented as the speaker of the evening and his opening remarks dealt with the origin and history of the Society and praise for the work done by the Committee on Nomenclature. This was followed by a very interesting and instructive talk on The Romance of Building, using the Waldorf Astoria Hotel as an example. By tracing the development of the Terminal Zone from the time of the first power plant to the present day, he brought out the changes that have taken place in building construction, engineering problems that were encountered during this particular project, and how these problems were solved.

Following the discussion of Mr. Driscoll's talk, C. R. Sabin spoke briefly on the status of the NRA Code for the Construction Industry.

A rising vote of thanks was extended to Mr. Driscoll and the meeting adjourned at 10:30 p. m.

Massachusetts

October 9, 1933—Pres. Leslie Clough called the meeting to order at 12:30 p. m. at Durgin Parks Restaurant where luncheon was served to 50 members and guests.

A motion was made that the regular order of business be dispensed with and the topic of Residential Air Conditioning was discussed. H. B. Smith spoke on humidity and temperature range of requirements for comfort and H. E. Hackinsmith explained the difficulties encountered and methods of overcoming them in the sale of residential air conditioning.

J. W. Brinton presented a paper on Residential Air Conditioning, giving his experience in this field and giving detailed data on winter and summer applications.

The meeting adjourned at 2:30 p. m.

Minnesota

September 24, 1933. The first meeting of the 1933-34 season was held at the Midway Club in St. Paul with an attendance of 24.

After dinner had been served, the meeting was opened by Pres. A. B. Algren and the minutes were read by Secy. C. E. Gausman and approved.

Vice-Pres. C. E. Lewis gave a report on the activities of the Program Committee and announced that the following arrangements had been made for the next three meetings: October 23—Pres. W. T. Jones, Boston, Mass.; November—Talk on the Decalorator; December—Annual Party.

A financial report was given by the treasurer.

The balance of the meeting was devoted to consideration of the N.R.A. Code for Engineers. Prof. F. B. Rowley opened the discussion by pointing out the sections of the code which were favorable and those which were not so satisfactory. Professor Rowley was followed by Mr. Lewis. A very interesting discussion was held in which all the members took part.

A. J. Huch moved that a committee be appointed, consisting of members who are acting as consulting engineers and others

interested, to discuss the code further with the idea of making a recommendation to the national secretary of changes deemed advisable, it being understood that such recommendations would have the endorsement of the entire chapter.

This motion was seconded and passed, after which the meeting was adjourned.

New York

October 16, 1933. Dr. C.-E. A. Winslow, director of the School of Public Health, Yale University, gave an address on Some of the Newer Physiological Considerations of Fresh Air and this was followed by an interesting discussion.

Dr. Winslow spoke of first efforts to eliminate bad air, rather than to obtain good air, to make up any deficiency of oxygen, to eliminate any excess of carbon monoxide and mysterious toxic effects, and so on to more recent ideas on temperature, air movement and humidity.

The speaker gave some details of the latest developments in radiant heating in England, where different instruments and terminology are used. He pointed out certain advantages of such a method for intermittent heating and for warming only certain parts of a room. He believed that in the future thermal interchange might no longer be considered alone as vital, but that such things as wave length effects, negative ions and nose effect of heat, would be considered and felt that decisions should not be made until solid evidence arrives, substantiating the worth of the many theories now being proclaimed.

Dr. Winslow also expressed the opinion that the time has not arrived for elaborate air conditioning of schools and homes, as the successful air conditioning of such places is a different problem than its application to buildings of other types.

The next speaker was J. G. Eadie, consulting engineer in New York, and the Society's representative on the Control Committee of the Professional Engineers Code for the Construction Industry. Mr. Eadie outlined all that had been done to make the code workable and a foundation upon which to build a more lasting structure. He also spoke of the elimination in the code of the many grievances affecting the heating and ventilating industry for years without previous steps having been taken to overcome them.

Many of the 75 members and guests in attendance joined in the discussion that followed.

Ontario

November 6, 1933. The regular meeting of the Ontario Chapter was held at the Royal York Hotel at 6:00 p.m. with 70 members and guests present.

Following a delightful dinner, Pres. W. P. Boddington announced that the Membership Committee had obtained 5 new members since the last meeting.

R. J. Thompson, Wilmington, Del., the principal speaker of the evening, was introduced by President Boddington and gave a very instructive lecture on Freon as a Refrigerant.

An interesting discussion followed, after which the meeting was adjourned.

Pacific Northwest

October 19, 1933—The first meeting of the Pacific Northwest Chapter for the year 1933-34 was held at the Engineers Club with Pres. P. M. O'Connell presiding. On this occasion, W. T. Jones, Boston, Mass., president of the A. S. H. V. E., was the guest and speaker.

A dinner at 6:30 p. m. preceded the meeting when President Jones spoke on the Status Quo of the Society.

The Chapter feels fortunate in having had President Jones as its guest, because his talk truly outlined the work of the A. S. H. V. E. and its accomplishments. His address was an inspiration to all and of material advantage in giving new determination to the Pacific Northwest Chapter and its officers, says the report of Secy. S. D. Peterson.

Western Michigan

October 9, 1933. After a summer recess, the first chapter meeting under the new administration was held at the Hotel Rowe, Grand Rapids. Following dinner, Pres. K. L. Ziesse conducted the program, including the business affairs of the Chapter and the reception of a report from S. H. Downs, of Kalamazoo, on the Semi-Annual Meeting of the Society.

A talk on The Refrigerant Freon—A Scientific Development was given by R. J. Thompson, Wilmington, Del., who explained that freon is non-toxic, non-inflammable and non-odorant and finds its most practical application to mechanical refrigeration systems for air conditioning and commercial cooling processes in public places. A number of interesting and spectacular demonstrations were made with Freon, indicative of its properties of rapid heat absorption, stableness and safety. A service lamp for detecting the refrigerant's presence in the air through leaks in the mechanical system was also shown.

The talk was exceptionally well presented and was interesting, educational and entertaining.

National Association for Better Housing Meets in Chicago

At a meeting of the *National Association for Better Housing*, held at the Union League Club in Chicago, on October 31 and November 1, the Society was represented by John Howatt, 2nd Vice-President, who reports an attendance of several hundred at each meeting and great interest and enthusiasm.

Morning and afternoon sessions were held on both days with J. Soule Warterfield, Chicago, chairman of the Organization Committee, presiding. The speakers were principally those in the U. S. Government service and the discussion largely covered procedures in obtaining federal aid for housing projects and the effects that would result from building a large number of homes in competition with properties already existing which cannot earn their operating charges.

Additional information may be secured from the association's headquarters at 59 East Van Buren St., Chicago, Ill.

Death of Frank I. Cooper

Frank Irving Cooper, distinguished for his work in architecture and engineering, died at his home in Wayland, Mass., on October 23. Mr. Cooper was born in Taunton, Mass., May 8, 1867, the son of Joseph J. and Mary A. Nichols Cooper, and was educated at Chauncy High School.

Selecting architecture for his profession, he studied with Henry Van Brunt, and then studied engineering with Harry Keith. He was a draftsman and superintendent for Sheply, Rutan and Coolidge and began independent practice in 1890. Since 1914 he had been president of the Frank Irving Cooper Corp. of Boston, Mass., and Hartford, Conn.

In Pennsylvania, where he began his work, he was architect of the Presbyterian Church at Coreopolis and, coming to Massachusetts, he planned and erected the Bristol County Court House and many other structures. One of his outstanding accomplishments was the building of the headquarters of the *National Education Association* in Washington. He had published a number of articles on municipal economies, schoolhouse planning and school grounds as well as on heating and ventilating and presented papers before many organizations.

Mr. Cooper joined the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS in 1911 and served as a member of the Council from 1914-16. He was a life member of the *Bridgewater Historical Society* and the *Old Colony Historical Society*.

He is survived by his widow and two sons, Frank L. and Gregory Cooper, to whom the Officers and Council extend their sincerest sympathy.

Illinois

November 13, 1933. Seventy-nine members and guests of the Illinois Chapter met at the Hotel Sherman and the newly elected president, C. W. DeLand, called the meeting to order at 7:30 p. m. The minutes of the previous meeting were read and approved.

The Chapter was honored by the unexpected visit of F. Paul Anderson, a Past President of the Society and dean of the College of Engineering of the University of Kentucky, whose words of greeting were welcomed by his many Illinois friends.

Vice-Pres. R. E. Hattis asked for the cooperation of all members to encourage attendance and increase the membership. The name of C. E. Price was added to the Chapter's roll.

President DeLand's announcements concerned the Chapter officers' luncheon with the members of the A. S. H. V. E. Council on October 25, the appointment of H. R. Linn as employment contact man, and the appointment of John Howatt as Society representative to the National Association of Better Housing. Mr. Howatt gave a report of the first meeting, which was held recently.

The new Meetings Committee chairman, S. I. Rottmayer, introduced the speaker, A. C. Willard, acting dean and director of the Department of Mechanical Engineering of the University of Illinois, who is also Technical Adviser to the Society's Committee on Research and a Past President.

Professor Willard discussed the subject of Theory and Practice in Heating and Ventilating Work in his usual forceful and dynamic manner. He traced the relationship between theory and practice from the days of Watt and Faraday to the present. Watt with his steam engine and Faraday with the dynamo proved that sound theory underlies sound practice. The engineer must appreciate the fact that conditions must be right to correctly coordinate theory and practice.

Professor Willard used many illustrations to emphasize these points, such as the flow of gases through ducts, the determination of the heat transfer coefficient of a building, boiler practice, radiation ratings, and human comfort determination. The conclusions reached were that averages may prove misleading, especially when the range from a maximum to a minimum is large; theory is not wrong, but often does not fit the conditions to which it is applied, because the practitioner does not appreciate all of the conditions involved; and that more studies are needed relative to the coordination of theory and practice.

Professor Willard has always been a popular speaker with Illinois Chapter members and this was evidenced by the attendance at this meeting. However, according to Secretary Hayes, the excellent work of the Membership Committee should not be overlooked.

Following Professor Willard's address, President DeLand brought the meetiing to a close with a pep talk and a few words regarding future Chapter programs.

St. Louis

November 1, 1933—Paul Sodemann, 1st vice-president of the St. Louis Chapter, called the meeting to order in the absence of Pres. C. A. Pickett. The meeting was preceded by dinner when the members were guests of the David Ranken Trade School.

Secy. C. R. Davis read the report of the Nominating Committee for chapter officers for 1934 as follows: *President*—Paul Sodemann; *1st Vice-President*—J. W. Cooper; *2nd Vice-President*—C. R. Davis; *Treasurer*—G. W. F. Myers; *Secretary*—A. L. Walters; *Board of Governors*—C. A. Pickett, J. M. Foster, E. E. Carlson and E. B. Evleth.

A. L. Walters, treasurer, reported a balance on hand as of October 30, 1933, of $354.72.

A communication was read from Mr. Kipp, secretary of the St. Louis Section of the *A. S. R. E.*, inviting chapter members to attend their November 17 meeting when the subject of Self-Contained Air Conditioning Units would be discussed.

Applications for membership were presented from G. L. Ranck and R. E. Clegg.

E. A. White, Employment Officer, reported on the activity of the Joint Engineering Council and his work in connection with this matter.

G. B. Rodenheiser, of the David Ranken Trade School, described an Air Conditioning Forum to be conducted at the school early in 1934. This forum will consist of eight weekly meetings, covering the various phases of air conditioning, with the idea of acquainting the general public and laymen with the factors involved in air conditioning. The papers and discussions at the meetings will be in charge of men connected with the industry, many of whom are members of the St. Louis Chapter of the Society.

The discussions will consist of air conditioning, definitions, etc.; heating and humidification; cooling and dehumidification; equipment required for cooling and dehumidification; cleansing and washing; air distribution and properties of air; control equipment, application, etc.; and engineering necessary for proper application of air conditioning.

Mr. Rodenheiser requested that the St. Louis Chapter sponsor this open forum and said that the local sections of the *Heating and Piping Contractors Association*, the *A. S. R. E.*, the *A. I. A.*, the Chamber of Commerce and other organizations would also be asked to serve as sponsors.

A motion in favor of this action was made by Mr. Myers, seconded by L. W. Moon, and carried.

J. D. Berkeley, Buffalo, N. Y., addressed the Chapter on Decalorators—Steam Vacuum Refrigeration and described its invention and evolution with the assistance of stereopticon slides.

On completion of his paper, Mr. Berkeley was given a rising vote of thanks for one of the best meetings of the year by the 65 members and guests present.

There being no further business, the meeting was adjourned.

Western New York

November 13, 1933. This meeting of the Western New York Chapter was held at Gandy's with 25 members and guests in attendance.

Roswell Farnham made a motion, which was carried, that Pres. D. J. Mahoney be named representative and J. J. Yager alternate, to serve the Chapter on the Nominating Committee.

A motion was made by W. F. Johnson and carried that a committee be appointed to select a new meeting place for the Chapter. The following committee members were selected: D. J. Mahoney, W. E. Voisinet and W. F. Johnson.

It was then decided to hold the annual Xmas stag party at the University Club on the night of December 18.

M. C. Beman introduced the speaker, M. E. Pendleton, whose subject was the Use of Cork in Our Industry. Mr. Pendleton's discussion was very interesting and instructive, tracing the development of raw cork from the tree to its place in the industry either as a sound or heat insulation medium.

The lively and lengthy discussion following Mr. Pendleton's talk was evidence of the interest created and a rising vote of thanks was given to him, according to the report of Secretary Voisinet.

Eleventh Oil Burner Show

The *American Oil Burner Association* announces completion of floor plans and other details for the 11th National Oil Burner Show to be held in Philadelphia at the Commercial Museum, March 5-9, 1934.

Owing to the interest in the working out of the Oil Burner Code and the fact that March will find the industry experiencing the code's full effect, it is estimated that the dealer attendance at the convention will exceed the Boston enrollment in 1932, which set a new high total.

CANDIDATES FOR MEMBERSHIP

The Constitution of the Society as now amended, requires the following mode of procedure in voting on applicants for membership in the Society. All applications for membership are to be sent to the Secretary and the names of applicants and their references shall be printed in the next issue of the JOURNAL of the Society or sent to the members in other approved manner as ordered by the Council. When replies are received from references, the Candidate's application shall be submitted to and acted upon by the Membership Committee as soon as possible.

When the Membership Committee has acted favorably upon a Candidate's application and assigned his grade, the Council shall vote upon the election of the proposed Candidate for membership by letter ballot. During the past month 45 applications for membership have been received and the names of these men and their sponsors are published in the following list.

Members are requested to scrutinize the list with care. The Membership Committee, and in turn the Council, urge the members to assume their share of the responsibility of receiving these candidates into membership by advising the Secretary promptly of any whose eligibility for membership is in any way questioned.

All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote.

Unless objection is made by some members by December 15, 1933, these candidates will be balloted upon by the Council. Those elected to membership will be notified by the Secretary immediately after election.

CANDIDATES	REFERENCES	
	Proposers	*Seconders*
ALFSEN, NIKOLAI, Partner, Alfsen & Gunderson, Oslo, Norway.	Alf Tjersland Wilh. Wilhelmsen (*Non-Member*)	H. P. Lysaker (*Non-Member*)
ANDERSON, DAVID B., Graduate Student, University of Minnesota, Minneapolis, Minn.	F. B. Rowley A. B. Algren	C. E. Gausman A. J. Huch
BEST, MILLARD W., Pres., Kolelectric Underfeed Stoker Co., Ltd., Hamilton, Ont., Canada.	W. R. Blackhall Thomas McDonald	W. P. Boddington J. S. Wood
BOLZ, HAROLD A., Graduate Asst., Case School of Applied Science, Cleveland, O.	M. B. Wright G. L. Tuve	V. T. Kartorie L. P. Quinlivan
BUFORD, J. W., Graduate Student, Harvard Engrg. School, Cambridge, Mass.	C. P. Yaglou Philip Drinker	W. F. Wells (*Non-Member*) Theodore Hatch (*Non-Member*)
BURDOIN, ALLEN J., Student, Harvard Engrg. School, Cambridge, Mass.	C. P. Yaglou Philip Drinker	Theodore Hatch (*Non-Member*) W. F. Wells (*Non-Member*)
CANDEE, BERTRAM C., Partner, Beman & Candee, Buffalo, N. Y.	D. J. Mahoney W. F. Johnson	W. E. Voisinet M. C. Beman
CLEGG, ROBERT R., Zone Repr., Owens-Illinois Glass Co, St. Louis, Mo.	C. R. Davis C. A. Pickett	J. M. Foster E. B. Evleth
COOK, H. A., Supt. of Htg., Vtg. & Sprinkling, University Plbg. & Htg. Co., Seattle, Wash.	W. W. Cox S. D. Peterson	P. M. O'Connell R. O. Granston
EPPRIGHT, JOHN O., City Sales, Stowe Hardware & Supply Co., Kansas City, Mo.	H. D. Betz J. H. Kitchen	Carl Clegg L. R. Chase
ERDLE, GARDNER F., Mfrs. Repr., Buffalo, N. Y.	W. F. Johnson D. J. Mahoney	W. E. Voisinet M. C. Beman
FARLEY, WILLOUGHBY S., Partner, Farley & Luther, Danville, Va.	J. B. Heard (*Non-Member*) W. H. Carter (*Non-Member*)	W. R. Harrison (*Non-Member*) R. B. Davis (*Non-Member*)
GESMER, JOSEPH, Student, Harvard Engrg. School, Cambridge, Mass.	C. P. Yaglou Philip Drinker	W. F. Wells (*Non-Member*) Theodore Hatch (*Non-Member*)
GREEN, JOSEPH J., Mfrs. Repr., Joseph J. Green Co., Buffalo, N. Y.	W. E. Voisinet W. F. Johnson	D. J. Mahoney M. C. Beman
GRIFFIN, DEWITT C., Secy. & Treas., May & Griffin, Inc., Seattle, Wash.	W. W. Cox S. D. Peterson	P. M. O'Connell W. E. Beggs
HEARD, R. G., In charge Oil Burner Dept., Imperial Oil Ltd., Toronto, Ont., Canada.	Thomas McDonald W. P. Boddington	M. W. Shears J. S. Wood
HENDRICKSON, HAROLD M., Mech. Engr., Carrier Engrg Corp., Los Angeles, Calif.	A. H. Simonds L. H. Polderman	J. F. Park A. B. Lang (*Non-Member*)
HOLLADAY, W. L., Mgr., Engrg. Dept., Geo. Belsey Co., Ltd., Los Angeles, Calif.	L. H. Polderman A. H. Simonds	J. F. Park A. B. Lang (*Non-Member*)
JONES, NOEL W., Student, University of Minnesota, Minneapolis, Minn.	F. B. Rowley A. B. Algren	C. E. Gausman A. J. Huch

CANDIDATES	REFERENCES	
	Proposers	*Seconders*
KAHAN, CHARLES, Student, Harvard Engrg. School, Cambridge, Mass.	C. P. Yaglou Philip Drinker	W. F. Wells (*Non-Member*) Theodore Hatch (*Non-Member*)
KING, ROY L., Graduate Student, University of Minnesota, Minneapolis, Minn.	F. B. Rowley	A. B. Algren
KOOISTRA, JOHN F., Engr., Carrier, Los Angeles, Calif.	A. J. Huch	C. E. Gausman
	J. F. Park	A. B. Lang (*Non-Member*)
LEES, JOHN T., Student, Harvard Engrg. School, Cambridge, Mass.	A. H. Simonds C. P. Yaglou Philip Drinker	L. H. Polderman Theodore Hatch (*Non-Member*) W. G. Hazard (*Non-Member*)
LESLIE, DONALD E., Graduate Student, University of Minnesota, Minneapolis, Minn.	F. B. Rowley	A. B. Algren
LOH, NAN SHEE, Andersen Meyer & Co., Shanghai, China. (*Advancement*)	A. J. Huch	C. E. Gausman
	W. R. Zuhlke	O. O. Oaks
LONGCOY, GRANT B., Maintenance Engr., Cleveland Board of Education, Cleveland, O.	F. B. Howell	H. L. Whitelaw
	F. A. Kitchen	W. E. Stark
MACHEN, JAMES T., The Ric-wiL Co., Chicago, Ill.	M. F. Rather	R. G. Davis
	C. Gottwald	J. J. Hayes
	S. I. Rottmayer	Albert Pelletier
MACLEOD, KENNETH F., Mgr., Htg. Dept., Crane Co., Seattle, Wash.	P. M. O'Connell	S. D. Peterson
	W. W. Cox	C. F. Twist
MADDUX, O. L., Chief Engr., United Gas & Fuel Co. of Hamilton, Ltd., Hamilton, Ont., Canada.	Thomas McDonald	M. W. Shears
	W. P. Boddington	W. R. Blackhall
MAY, CLARENCE W., Pres., May & Griffin, Inc., Tacoma, Wash.	W. W. Cox	P. M. O'Connell
	S. D. Peterson	W. E. Beggs
NEWCOMB, L. B., Engr., Phila. Elec. Co., Philadelphia, Pa.	Karl Rugart Benjamin Adams	Samuel Gross
NOTTBERG, GUSTAV, Htg. Estimator, U. S. Engrg. Co., Kansas City, Mo.	E. K. Campbell	Carl Clegg
	H. J. Nottberg	W. A. Russell
PIERCE, EDGAR D., Engr., Carrier Engrg. Corp., Los Angeles, Calif.	A. H. Simonds	J. F. Park
	L. H. Polderman	A. B. Lang (*Non-Member*)
PIERCE, WILLIAM MACL., Student, Harvard Graduate Engrg. School, Cambridge, Mass.	C. P. Yaglou Philip Drinker	Theodore Hatch (*Non-Member*) W. F. Wells (*Non-Member*)
RANCK, GUY L., Office Mgr., C. A. Dunham Co., St. Louis, Mo.	G. W. F. Myers	Paul Sodemann
	L. W. Moon	E. E. Carlson
RILEY, EDWARD C., Student, Harvard University, Cambridge, Mass.	C. P. Yaglou Philip Drinker	W. F. Wells (*Non-Member*) Theodore Hatch (*Non-Member*)
RITCHIE, A. G., Pres., John Ritchie Ltd., Toronto, Ont., Canada.	W. R. Blackhall	E. T. Flanagan
	W. P. Boddington	J. S. Wood
SCOFIELD, PAUL C., Engr., Carrier Engrg. Corp., Los Angeles, Calif.	A. H. Simonds	J. F. Park
	L. H. Polderman	A. B. Lang (*Non-Member*)
SEEPE, PAUL E., Sales Engr., Minneapolis-Honeywell Reg. Co., St. Louis, Mo.	E. B. Evleth	Paul Sodemann
	C. A. Pickett	H. W. McLarney
SPIELMANN, H. J., Air Cond. Engr., The Vilter Mfg. Co., Milwaukee, Wis.	C. H. Randolph	G. L. Larson
	J. S. Jung	E. A. Jones
SUNDELL, SAMUEL S., Graduate Student, University of Minnesota, Minneapolis, Minn.	F. B. Rowley	C. E. Gausman
	A. B. Algren	A. J. Huch
VAN HORN, H. T., Dist. Mgr., Detroit Stoker Co., Minneapolis, Minn.	L. C. Gross	W. F. Uhl
	C. E. Gausman	D. M. Forfar
WHITTALL, E. T., Vice-Pres. & Managing Dir., May Oil Burner of Canada, Ltd., Toronto, Ont., Canada.	Thomas McDonald	W. P. Boddington
	M. W. Shears	W. R. Blackhall
WOODRUFF, WILBUR J., Proprietor, Woodruff Coal Co., Urbana, Ill.	A. P. Kratz	W. H. Severns
	A. C. Willard	M. K. Fahnestock
WYMORE, FRED C., Student, Finlay Engrg. College, Kansas City, Mo.	H. D. Betz	J. H. Kitchen
	E. K. Campbell	Carl Clegg

Candidates Elected

In past issues of the JOURNAL of the Society the names of the following men were listed as Candidates for Membership. The membership grade of each Candidate has been assigned by the Membership Committee and balloted upon by the Council. We are now instructed by the Council to post herewith, as required by Art. II, Sec. VIII, of the By-Laws, the following list of candidates elected:

MEMBERS

HAUAN, MERLIN J., Consulting Engr., Seattle, Wash.

JOYCE, HARRY B., Consulting Engr., Erie, Pa. (*Reinstatement*)

ASSOCIATES

BLISS, GEORGE L., Engrg. & Sales, Allis-Chalmers Mfg. Co., Kansas City, Mo.

CHRISTIE, ALFRED Y., Salesman, U. S. Radiator Corp., Boston, Mass.

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Heating • Piping and Air Conditioning

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As will be noted, these abstracts are classified under several rather general heads. In searching for information on a specific subject, it will be well to look through the abstracts under the most suitable heading, and also to look through those under related headings. For example, some of the heating articles also contain information on air conditioning, and vice versa, *as the grouping has been made on the basis of the subject most prominently covered in the article.*

The index to the Journal Section *of the* American Society of Heating and Ventilating Engineers *is separate* (*see page* 641).

Air Conditioning—General

What Does the Term "Air Conditioning" Mean?
No. 7. *July*, 1933. *p.* 70 (*adv. section*).
Definition of *A. S. H. V. E. Guide;* comments of W. H. Driscoll; "ventilation" will come to mean air change only in plants, mines, toilets, etc.

Modern Equipment for Savings and Profit (Many Developments in Air Conditioning).
No. 1. *January*, 1933. *p.* 43.
Modernization with air conditioning and newly-developed equipment. 17 i.

Check Drives When Modernizing, by W. A. Meyer.
No. 4. *April*, 1933. *p.* 206.
Opportunities for modernizing pump, fan, and compressor drives. 2 i.

Reduces Air-Conditioning Costs with Compressor-Equipped Plant Storing Refrigerating Effect, by Charles S. Leopold.
No. 6. *June*, 1933. *p.* 296.
Comparison of ice and mechanical refrigeration plants should be made on same basis; storing refrigerating effect in compressor plants; restaurant plant stores ice, cuts peak load; brief description of apparatus; cost comparison of compressor ice-storage plant; need for further study to reduce air-conditioning costs. 1 i.

Control for a Steam-Jet Air-Conditioning System, by R. R. Houser.
No. 8. *August*, 1933. *p.* 399.
Six-ton steam-jet conditioning plant in Kansas City store; gas-fired boiler uses natural gas; control system and its operation explained in detail; fan controlled by time switch; amount of outdoor air controlled; allowing for occupancy; results secured with the system; diagram of equipment and control. 1 i.

A Decade of Progress in Motor Control Is Shown by These Jobs.
No. 12. *December*, 1933. *p.* 608.
View typical of control for fan and pump motors as installed ten years ago; view of similar equipment as installed now; improvements which have been made. 2 i.

Noise in Heating and Air Conditioning, by Samuel R. Lewis.
No. 4. *April*, 1933. *p.* 198.
Where it occurs; prevention; isolation of fan and motor; treating machinery room with absorbent; beam grillage to carry piping; noise from air flow; baffles; air-cleaning devices as noise bafflers; test of filter installation in radio-studio job. 1 i.

Effect of Water and Oil on Natural Cork Discussed.
No. 6. *June*, 1933. *p.* 305.
Natural cork used as sound isolation unaffected by water or oil (comment by B. A. Doane on article above); author's reply.

Testing the Fans for the East Boston Traffic Tunnel, by J. E. Gill.
No. 8. *August*, 1933. *p.* 414.
Brief description of tunnel and its ventilation; specifications for and testing of the 28 fans; small geometrically similar fan tested; flow-nozzle method of testing; test of full-size fan; exhaust fan-room tested; causes of losses. 3 i.

Specifications for Traffic Tunnel Fans.
No. 9. *September*, 1933. *p.* 73 (*adv. section*).
Comment by A. C. Davis on above article; author's reply.

Psychrometer Has Two Wet Bulbs.
No. 4. *April*, 1933. *p.* 206.
Bureau of Standards develops psychrometer for precise humidity measurements with two wet bulbs; amount of error; thermometric wet-bulb supply pre-cooled to evaporation temperature.

Air Conditioning—Commercial

Modernizes and Profits with Air Conditioning, by James M. Todd.
No. 1. *January*, 1933. *p.* 8.
Air-conditioning system installed in D. H. Holmes Co., department store, New Orleans, La.; cost; advantages obtained; cost of power cut; spaces conditioned; machinery room sound isolated; plant has 242-ton capacity; pumps, fans, drives, control, cooling tower; air delivery; air to booths individually controlled; comfort zone in Southern climates and comfort chart. 5 i.

Unit-Type Air Conditioning System Modernizes Large Department Store, by A. W. Moulder.
No. 3. *March*, 1933. *p.* 137.
Unit-type cooling and dehumidifying system in Neiman-Marcus Company store, Dallas, Tex.; 50 units used; why unit system was chosen; all equipment is concealed; method of installation; ventilation; construction of units; non-freeze liquid circulated from central refrigeration plant; capacitor-type motors; connected motor load; system's features; results secured. 13 i.

17-Year-Old Office Building Meets Competition by Air Conditioning, by Ralph E. Phil'ips.
No. 5. *May*, 1933. *p.* 250.
Heard office building, Phoenix, Arizona; little space in building, equipment on roof; insulation; zoning of air-conditioning system; 150-ton ammonia refrigeration compressor; complete operating logs aid efficient operation (cut of log); connected motor load; power cost for one season; cost of air conditioning; advantages. 2 i.

Conditions Air for Six-Floor Tenant, by M. O'Connell.
No. 9. *September*, 1933. *p.* 463.
22 E. 40th St. building of New York Trust Co., New York City, modernized with air conditioning; steam-jet refrigeration; cooling tower saves on water cost; air distribution; dehumidifier on 7th floor; booster fan unit on each floor; cooling tower consists of air washer in basement; automatic control electric throughout; condenser water requirements at various temperatures; city water to help cooling tower over peaks; discharge of air from cooling tower; balancing inside-outside conditions; space required for air-conditioning plant. 7 i.

Radio City's British Empire Building Completely Air Conditioned, by André Merle.
No. 5. *May*, 1933. *p.* 239.
Six-story shop and office building; air conditioning system has three zones; duct-riser diagram; 300-ton steam-jet refrigeration unit; refrigeration equipment; chilled-water flow diagram and diagram of cold-water piping; pumping and controlling chilled water; condenser-water piping; cooling tower; wet-bulb type of humidity control; pipe shaft; air distribution and introduction; pH neutralizer; heat and sound insulation; ionization equipment. 8 i.

Distributing Conditioned Air in Dime Savings Bank Building, by Realto E. Cherne.
No. 10. *October*, 1933. *p.* 505.
Air conditioning of The Dime Savings Bank Bldg., Brooklyn, N. Y.; the building; dehumidifiers and supply fans; 92-ton centrifugal compressor; scheme of air distribution (safe-deposit department; main banking space); "high" and "low" distribution systems; compressed-air type control; indicating and recording instruments; operation of the plant. 4 i.

Flexibility a Feature of the Completely Conditioned Philadelphia Saving Fund Society Building, by Joseph M. Dowling.
No. 8. *August*, 1933. *p.* 409.
The building; zoning the system to hold sliding scale; conditions maintained; instruments; special outlets handle low-temperature air; scheme of air distribution; evaporative cooling conserves refrigeration power; cold-water piping layout; synchronous motors, cut-out couplings, correct power factor; cooling tower. 7-i.

Fan-Motor and Riser-Valve Control in a Partially-Air-Conditioned Building, by R. C. Allen.
No. 12. *December*, 1933. *p.* 603.
Gulf Building, Pittsburgh, Pa.; zone and clock control of steam; humidified air for lower floors; control of the fan motors; the question of air conditioning modern office buildings. 4 i.

New National Archives Building Conditioned to Protect Records.
No. 6. *June*, 1933. *p.* 305.
Air-treating system for National Archives Building, Washington, D. C., handles 330,000 cfm; the conditions maintained; advantages. 1 i.

Servicing the Air Filters for 140 Unit Ventilators, by W. H. Junker.
No. 6. *June*, 1933. *p.* 302.
Cincinnati & Suburban Bell Telephone Co. building; atmospheric dust in Cincinnati; need for filtered air; 140 units ventilate building; filter-cleaning equipment essential; how the filters are serviced; diagram and photo of servicing room and equipment; construction of cleaning equipment; pumps circulate cleaning fluid. 2 i.

Filtered Air Relieves Hay Fever, by William H. Welker, B. Z. Rappaport, and Tell Nelson.
No. 7. *July*, 1933. *p.* 348.
Research at College of Medicine of University of Illinois; problems in filtering air for removing pollen; leakage around filter; determining efficiency of filters; clinical observations on hay-fever patients; on pollen-asthma patients; filtered air gives relief and increases efficiency of hay-fever patients; pollen-asthma patients respond more slowly; summarized results of studies. 5 i.

St. Louis Center of "Cooling Belt,' Survey Indicates.
No. 7. *July*, 1933. *p.* 346.
Three maps prepared by Industrial Club of St. Louis show St. Louis to be near center of so-called "cooling belt." 3 i.

Millions Have Experienced Air Conditioning at the Chicago Fair.
No. 11. *November*, 1933. *p.* 558.
"Little Theater is Air Conditioned—Ten Compressor Units Provide 25-Ton Capacity," by G. E. Simons; "Gas-Fired Boiler Supplies 100-Lb Steam for Steam-Jet Air-Conditioning Unit at the Fair," by E. D. Quirke; "Time-Fortune Pavilion Has Provided Air-Conditioned Reading Room for Public Use"; "World's Smallest Theater Cooled with System having a Capacity of Four Tons"; "New High-Speed Railroad Coach on Exhibit; Air Conditioning Is Among Its Features." 4 i.

Large Air Volume Exhausted from "A Century of Progress" Buildings.
No. 5. *May*, 1933. *p.* 256.
Method of ventilating windowless exposition buildings; diagram of typical exhaust ventilation system. 5 i.

Chicago World's Fair Proves Air Conditioning Attracts the Public.
No. 7. *July*, 1933. *p.* 360.
Three-hundred seat theater is air conditioned; chemical company has conditioned display; air conditioning on display. 4 i.

A Century of Progress Exposition.
No. 6. *June*, 1933. *p.* 289.
Processes, not products, featured; exhibit shows generation, distribution, and utilization of electricity; air conditioned auditorium; electricity in industry; oil-line pumping station control; operation of a motor; air-filter exhibit; oil-burning equipment; development in piping and valves; other features; the buildings. 8 i.

Air Conditioning—Industrial

Air Conditioning Saves Six Years in Making World's Largest Mirror, by M. M. Lawler.
No. 11. *November*, 1933. *p.* 547.
Construction of 200-in. astronomical telescope at California Institute of Technology, Pasadena, Calif.; the mirror (weight, dimensions, use, etc.); glass sensitive to temperature changes; construction of mirror; advantages of controlled humidity; importance of air conditioning in testing; air-conditioning requirements; operation of conditioning system; electric heaters supply auxiliary heat; control; 60-ton refrigeration plant; methyl chloride compressor; filters; motor control; spray pond; insulation of piping, ducts, and housings. 6 i.

Movie-Makers Teach a Lesson in Product Improvement by Air Conditioning, by L. H. Polderman.
No. 6. *June*, 1933. *p.* 292.
Metro-Goldwyn-Mayer developing plant, Culver City, Calif.; air conditioning maintains production schedule; reasons for air conditioning; elimination of dust; prevention of static electricity; constant temperature and humidity; controlling temperature of developing solutions; air- and solution-control systems; humidity and temperature requirements; drying cabinets a part of the air conditioning system; control. 5 i.

Modernized Humidification Will Aid Textile Mills in Maintaining Profits, by George Fuller.
No. 8. *August*, 1933. *p.* 394.
Effect of *N. I. R. A.* code on cotton-textile industry; value of humidity control: what control means (examples); modern equipment, technique important.

Air Conditioning in the Modern Brewery, by L. L. Simmons.
No. 5. *May*, 1933. *p.* 245.
Ventilation needed for comfort; cooling a major problem; cooling requirements; unit coolers; exhausting carbon dioxide gas; need for bacteria-free air; close control of yeast storage; malting the grain; increased use of air conditioning probable. 1 i

Units Condition Concrete Testing Laboratory.
No. 2. *February*, 1933. *p.* 104.
Air conditioning units maintain constant conditions in Bureau of Reclamation's two laboratories in Denver, Colo.; concrete for Hoover Dam studied; removing heat generated by cement; method of obtaining close temperature and humidity control; electric strip heaters and atomizing humidifiers used. 2 i.

Many Economies Made by Using Air Conditioning in Ripening Fruits, by James J. Murray.
No. 7. *July*, 1933. *p.* 352.
Artificial ripening of tomatoes, bananas, etc., at Harry Becker Co. plant, Detroit, Mich.; the air-conditioning equipment; ethylene gas hastens ripening; advantages. 2 i.

The Drying of Solids, by T. K. Sherwood and E. W. Comings.
No. 4. *April*, 1933. *p.* 187.
Manner in which solids dry; initial adjustment period; constant-rate period; studying the drying of a solid; research at M. I. T.; six general types of drying-rate curves; equilibrium or hygroscopic moisture content; regain curves for keiselguhr, silk, and tobacco; relation of moisture content to drying time; example showing use of data given in an industrial drying problem. 5 i.

Cooling Water for Air Conditioning or Industrial Process Uses with Steam Jet Refrigeration, by Walter L. Fleisher.
No. 2. *February*, 1933. *p.* 77.
Steam and its temperatures; history of steam-jet refrigeration; how a steam ejector operates; pressure and temperature in the condenser; removal of air and inert gases; use of warm water from primary condenser; removal of cooled water; steam consumption; effect of ratio of compression; effect of condenser pressure; effect of initial steam pressure. 8 i.

Cooling Water for Industrial Uses with Steam-Ejector Refrigeration, by Walter L. Fleisher.
No. 3. *March*, 1933. *p.* 147.
Cool water for process influences plant location; estimating cost of water; refrigeration saves freight charges; locating equipment at point of cool-water use; steam-jet units for industrial air conditioning; steam for cooling aids boiler load; steam-ejector refrigeration not new; summary of features; limitations; modernization with steam-jet refrigeration; storing cold water.

Operation, Maintenance of Cloth-Screen Dust Collectors, by W. F. Terry.
No. 5. *May*, 1933. *p.* 259.
Dust collection; operation of dust-collection system; diagram of system; traps or separators grade dusts; importance of maintenance; cleaning the screens; rapping; emptying hoppers; disposal of dust; preventing air, water, and dust leaks; causes of screen wear, classifiers protect screens. 1 i.

Operation, Maintenance of Cloth Screen Dust Collectors, by W. F. Terry.
No. 6. *June*, 1933. *p.* 304.
Maintenance of arrester case; piping should be designed for easy maintenance; care of fans and motors; prevention of fire; advantages of regular general survey of plant; a schedule for inspection; summary.

Foundry Saves $6,000 Annually in Exhaust-Fan Bearing Maintenance, by Francis A. Westbrook.
No. 2. *February*, 1933. *p.* 94.
Ferro Machine and Foundry Co., Cleveland, O., modernizes 13 exhaust fans with dust-tight heavy-duty self-aligning adapter-type ball-bearings; service conditions severe; savings made. 1 i.

Industrial Fan Drives Offer Power-Saving Possibilities, by Robert W. Drake.
No. 12. *December*, 1933. *p.* 595.
Importance of power economy for pumps, fans, etc.; saving power in industrial exhaust and ventilating systems; how savings may be obtained; variation of motor speed; special fan runners; changing drive pulleys, sheaves, or sprockets. 3 i.

Modernizes Fan and Compressor Drives.
No. 2. *February*, 1933. *p.* 95.
(On the Job) automobile body plant modernizes flat belt drives by applying motor base to maintain proper tension in short-center flat-belt drive; advantages; new fan drive cuts slippage, saves power. 2 i.

Economy in Mine Ventilation.
No. 7. *July*, 1933. *p.* 347.
Engineering Experiment Station of University of Illinois reports results of study of mine ventilation in bulletin; the study and the results.

Heating—General

Modern Equipment for Savings and Profit (How Modern Heating Equipment Saves).
No. 1. *January*, 1933. *p.* 22.
Actual examples of modernization of heating systems in plants and buildings and recently-developed equipment; control cuts cost; stokers modernize plants; new types of radiation; modernizing with unit heaters. 38 i.

What Will Be the Future Development of Heating and Air Conditioning? by Willis H. Carrier.
No. 1. *January*, 1933. *p.* 16.
Developments in zoning heating systems, central-station steam, panel heating, concealed radiation, forced convection, fuel burning, distribution of conditioned air, refrigeration for air conditioning, and need of air conditioning, discussed.

Modernize the Term "Square Foot"? by Samuel R. Lewis.
No. 1. *January*, 1933. *p.* 15.
Adopt new term for square foot of steam and hot-water radiation?; new unit and its use discussed.

Data Sheets for Calculating Heating Surface for Buildings, by Price L. Rogers.
No. 4. *April*, 1933. *p.* 203 (*and consecutive issues through No.* 12, *December*, 1933).
Series of charts for computing heat losses from buildings for exposures up to 500 sq ft and coefficients from 0.02 to 1.12; chart for infiltration up to 26,400 cu ft; chart for proportionate heating surface required for other than conditions used as basis; and chart for pounds of steam and equivalent heating surface for heating domestic service water. Explanation of use appears in April issue. 9 full-page charts.

Design Temperatures for Heating Plants Based on a Fixed Overload, by L. C. Price.
No. 12. *December*, 1933. *p.* 598.
No hard-and-fast-rule for establishing design temperatures for heating plants; method using fixed percentage of overload; advantages; design temperatures for several cities.

A Method of Cleaning Radiators, by G. D. Winans.
No. 12. *December*, 1933. *p.* 607.
Thermostatic traps on radiators in large club building plugged with dirt; method of "vacuum cleaning" radiators devised; apparatus; results; how to prevent such trouble. 2 i.

Steam Generation in Boilers.
No. 11. *November*, 1933. *p.* 76 (*adv. section*).
Answer to question by Samuel R. Lewis on generation of steam in boilers burning solid and liquid fuel.

Control'ing Motors for Temperature Control Systems—Compressors—Oil Burners—Stokers, by Samuel R. Lewis.
No. 2. *February*, 1933. *p.* 100.
Operation of an electric temperature control system—positive operator, reversing operator; control of compressor motors; an oil-burner motor control; controlling stoker motors; controlling unit-heater fan motors; protection of motors. 7 i.

Heating and Ventilating Airplanes, by William E. Berchtold.
No. 8. *August*, 1933. *p.* 402.
The aircraft heating and ventilating problem; present methods of heating planes; liquid and vapor systems are promising; plane ventilation research needed. 3 i.

Heating — Buildings and Institutions (including Underground Piping)

(Also See "Modernization")

Hot-Water Heating for Skyscrapers, by T. S. Tenney.
No. 2. *February*, 1933. *p.* 82.
Heating system in Sixty Wall Tower Building, New York City; street steam drives turbines, exhaust heats water; use of condensation; six heating zones; top zone heated by humidified warm air; observation gallery can be cooled; flow mains divided for warm and cold exposures; heating surfaces enclosed; central control board aids operation; new developments make such systems possible. 5 i..

Control Reduces Steam Consumption 22 Per Cent, by W. H. Meloan.
No. 7. *July*, 1933. *p.* 351.
One saving can be superimposed upon another if they are not obtained by duplicating equipment; a case in point—the Consumers' building, Chicago; steam is purchased; control system installed; graph shows reduction in steam used for heating; careful operation and control tell. 1 i.

Application of Electric Heating to Office Buildings, by Lee P. Hynes.
No. 7. *July*, 1933. *p.* 358.
General office building of Kingsport Utilities Co., Kingsport, Tenn.; electric-heating and air-conditioning system; automatic regulation; ducts; auditorium; local office of Atlantic City Electric Co., Wildwood, N. J.; the electric-heating equipment and air filters; cost of operation. 11 i.

New Terminal Has Novel Features.
No. 7. *July*, 1933. *p.* 337.
Heating and ventilating systems of the Cincinnati Union Terminal (railroad); steam piped one mile from power house; ventilation systems; warm air circulated in extremely large double window; 14 units care for roof losses; heating the concourse; condensation from vestibule units is cooled by entering air; small movie theater is air-conditioned; brine-type dehumidifier; general features of the Terminal and history of development. 6 i.

Toledo Schools Expel High Heating Costs, by Samuel R. Lewis.
No. 1. *January*, 1933. *p.* 12.
Skillful operation of plant in Woodward high school cuts cost

from 95.1c per 1,000 cu ft for first season to 77.5c second season; first year with a stoker plant at DeVilbiss school; stokers increase capacity at Cherry school, enable heating of new Feilbach school, cut cost 75c per 1,000 cu ft; table showing cost of fuel for heating schools in various cities.

At University of Colorado—Master Control Valves Save Steam, by W. E. Brockway and George S. Dobbins.
No. 11. *November*, 1933. *p.* 556.
Comparison of amount of steam required to heat buildings as it had been done in the past, and the amount required with a motorized valve on the main steam supply, actuated by a thermostat; plan of tests; results of tests; conclusions based on tests. 6 i.

Meeting Special Heating Needs When Main Plant Is Shut Down, by H. H. Angus.
No. 3. *March*, 1933. *p.* 144.
Central steam heats Toronto university buildings; heat needed at all times in a greenhouse and in a laboratory; hot-water converter, oil-fired auxiliary hot-water boiler used for former; control; oil-fired auxiliary steam boiler heats laboratory; control and operation. 2 i.

Planning a Central Heating Plant for a School or Institution, by Alfred Kellogg.
No. 4. *April*, 1933. *p.* 191.
Definition of district and central heating; problem of heating group of institutional buildings; buildings of various ages; types of building heating systems; modernization of the systems; locating boiler plant; choosing the type of boilers; selecting the fuel; purchase or generation of electricity; distribution of steam; types of conduits and tunnels; drainage. 10 i.

Planning a Central Heating Plant for a School or Institution, by Alfred Kellogg.
No. 5. *May*, 1933. *p.* 242.
The boiler house and stack; choosing the pipe material; planning distribution of steam; piping insulation; keeping steam on lines prolongs life. 4 i.

Central Steam Plant and Pipe Tunnels Keep Heating Costs Down at U. of C., by Charles Levin.
No. 2. *February*, 1933. *p.* 90.
Reasons for building new plant at University of Chicago; growth of heating load; tunnel waterproofed; sizing pipe; returning condensation from one-pipe gravity and two-pipe vacuum heating systems; removing condensation from lines; piping materials and insulation; expansion of piping. 7 i.

Efficiency of an Underground Steam Line, by William S. McLeish.
No. 3. *March*, 1933. *p.* 150.
(On the Job); underground steam distribution system at State Teachers Normal School, Ewing Township, N. J.; section tested for efficiency; results of test and recorded data.

Heating—Industrial

(Also See "Modernization")

Modern Unit Heaters Promote Effective Plant Heating with Economy.
No. 9. *September*, 1933. *p.* 445.
Advantages of unit heaters for modernizing plant heating systems; guide for determining suitability of unit heaters; maintenance guide for plant unit-heater systems; examples of actual installations, giving results; development in unit heaters. 7 i.

Plants Report Savings from Modernizing with Unit Heaters, by A. W. Moulder.
No. 7. *July*, 1933. *p.* 347.
Savings of 20 to 50 per cent reported; reasons for savings; installing strainers in supply instead of return connection to protect tubes.

The Modern Unit Heater a Production Aid.
No. 10. *October*, 1933. *p.* 510.
Unit heaters solve many "process problems"; humidifying units provide proper conditions for product (leather shoe sole plant); units replace pipe coils for lumber drying; units dispel fog and steam (dye-houses, etc.); units speed paint drying (truck bodies); miscellaneous applications. 4 i.

Unit Heaters Answer Many a Process Problem, by Laurin J. Zorn.
No. 5. *May*, 1933. *p.* 258.
(From an interview with Kimball Burr); unit dispels steam and vapor in Agar Packing and Provision Co. plant, Chicago; preventing condensation on walls; unit heater in smoke house; advantages obtained. 1 i.

Trapping Unit Heaters for Industrial-Plant Heating.
No. 11. *November*, 1933. *p.* 561.
The problems to be considered; effect of pressure on capacity; differential and working pressure; installation of traps; elimination of air; strainers and dirt pockets; valves; diagrams showing installation methods. 10 i.

Piping—General

The Status of Piping Standardization Today, by Sabin Crocker.
No. 9. *September*, 1933. *p.* 455.
Classification of piping standardization projects; dimensional standards; *American Standards Association; A. S. A.* standards already published; standards in preparation; steel flanged standard; adjusted service pressures for power piping below and above 750 F; possible method for establishing allowable service pressures at high temperatures (chart). 1 i.

Piping Standardization by Sabin Crocker.
No. 10. *October*, 1933. *p.* 500.
Wrought-iron and wrought-steel pipe standards; reasons for new standards; attacking the problem; use of the standard; proposed American tentative standard—wrought-iron and wrought-steel pipe (table); many formulas considered; dimensions and weights of lap-welded and Grade *A* seamless steel pipe for high-temperature service (table); boiler code pipe formulas; modified formula developed; comparison of internal-fluid-pressure formulas for pipes and cylinders (graph); wall thickness. 1 i.

Piping Standardization—Materials Specifications, by Sabin Crocker.
No. 11. *November*, 1933. *p.* 552.
Establishing a standard under *A. S. T. M.* procedure; *A. S. T. M.* specifications and their application to service; listing and explanation of materials specifications for piping (bolting, castings, forgings, pipe); application of various specifications.

Piping Standardization—Materials Specifications, by Sabin Crocker.
No. 12. *December*, 1933. *p.* 599.
National piping specifications other than *A. S. T. M.*; pipe for fusion welding; piping materials for service at temperatures up to 1100 F (bolts, pipe); properties of several alloy-steel piping materials suitable for operating temperatures above 750 F (table). 1 i.

Modern Equipment for Savings and Profit (Piping Developments are Numerous).
No. 1. *January*, 1933. *p.* 34.
Actual examples of modernization of industrial and building piping and recently-developed equipment; flow meters; valves; traps; welding and welding fittings; supports and expansion; piping materials; insulation; pumping equipment. 21 i.

Modern Maintenance Spots Waste in Piping, by W. H. Wilson.
No. 1. *January*, 1933. *p.* 19.
(On the Job); look for sources of waste, then repair and modernize; use of flow meters; utilization of condensate; check bypass valves for leakage; not always necessary to install bypass valves; returning condensate through overhead line. 3 i.

Supervision, Proper Equipment Save Time and Money in Piping Maintenance, by W. H. Wilson.
No. 11. *November*, 1933. *p.* 567.
Importance of careful supervision in piping maintenance work illustrated by example of replacement of an expansion joint; proper tools and equipment, including lighting; time-saving suggestions. 1 i.

Legalizing Beer Means Modernization of Old Breweries, by R. C. Doremus.
No. 1. *January*, 1933. *p.* 18.
Rehabilitation of old breweries; process largely steam cooking; modern plants want dry steam; flooded ammonia coolers finding favor; float control; unit coolers will find use; temperatures required in refrigerated cellars; piping must be properly designed.

Practical Notes on Pipe Welding, by Arthur E. Christen.
No. 3. *March*, 1933. *p.* 146.
Discussion of article describing welding piping in Field office building, Chicago, in August, 1932, issue; rolling of pipe being welded; manner of tack welding important; welding a valve and fitting assembly.

Welding Galvanized Piping.
No. 8. *August*, 1933. *p.* 413.
Electrolysis and galvanic corrosion; experiences with dissimilar metals in piping systems; cross-sections of fusion weld and bronze weld; what happens when galvanized pipe is welded. 1 i.

For Testing Castings, Forgings, Welds—Navy Used Rays from Radium, by Charles S. Barrett.
No. 4. *April*, 1933. *p.* 208.
Development of gamma-ray radiography by Naval Research Laboratory; nature of gamma rays; process of radiography with gamma rays; inspecting flanges in installed line, etc. 3 i.

Leak-Tight Joints—600 to 550,000 Lb.
No. 5. *May*, 1933. *p.* 247.
Comments on previous articles on leak-tight joints and reply by author, F. E. Wertheim; computing gasket pressures; "lock-head" type of joint for high pressure apparatus. 1 i.

Bad Threads and Their Cause, by W. H. Wilson.
No. 3. *March*, 1933. *p.* 150.
(On the Job); care of threading equipment and its operation to insure good pipe threads.

Tappings for Gage Piping, by W. H. Wilson.
No. 6. *June*, 1933. *p.* 73 (*adv. section*).
Importance of giving attention to gage- and other small-size piping; suggestions.

Piping—Process

Bernoulli's Theorem—What It Means, by J. C. Reed and E. E. Ambrosius.
No. 2. *February*, 1933. *p.* 111.
Bernoulli's work and his theorem; meaning of theorem explained; sketch of Bernoulli. 3 i.

The Flow of Fluids in Pipes, by Emory Kemler.
No. 5. *May*, 1933. *p.* 252.
Types of fluid flow; dimensional homogeneity; critical Reynolds' number; stream-line flow; analyses of turbulent flow data (method of analyzing data, smooth pipes, new steel pipes); conclusions; table of experimenters whose data are analyzed; charts showing test results for Reynolds' number and friction factor for flow in new steel pipes. 2 i.

The Flow of Fluids in Pipes, by Emory Kemler.
No. 6. *June*, 1933. *p.* 298.
Flow of incompressible fluids; pressure drop in a pipe; viscosity of the fluid; viscosities of several typical fluids (chart); three types of flow problems; examples; viscosity curve for typical lubricating oil; establishing friction factor for different pipes; friction factor curve for rough pipes (chart); when pipe is not circular. 4 i.

A Series of Charts to Simplify Flow and Pressure-Drop Calculations for Process Piping, by Emory Kemler.
No. 10. *October*, 1933. *p.* 513.
Charts simplify calculation of pressure-drop and flow of liquids of various specific gravities in pipe; allowing for roughening and accumulations; turbulent flow; example of use of charts. Full-page charts for 1-in. and 2-in. standard steel pipe; conversion chart for kinematic viscosity and viscosity in Saybolt seconds. 3 i.
Chart for 1¼-in. standard steel pipe, page 555, November, 1933.
Chart for 1½-in. standard steel pipe, page 606, December, 1933.

Newport Industries, Inc., Save Time and Money by Prefabrication of Process Piping, by E. F. Sisson.
No. 8. *August*, 1933. *p.* 397.
The process; involves considerable piping; prefabrication of

aluminum piping secures many economies; ten different pieces required; sketches of the required assembly pieces; piping welded; the savings. 1 i.

Piping Services in a Brewery.
No. 4. *April*, 1933. *p.* 200.
Atlas Brewing Co. plant, Chicago; the piping services required in a brewery; the beer-making process; bottling the beer; steam supply; water supply; compressed air. 7 i.

Pipe Welding Plays an Important Part in Modernizing Breweries, by F. W. Rabe.
No. 10. *October*, 1933. *p.* 509.
Applications of pipe welding in modernizing Anheuser-Busch brewery, St. Louis, Mo. (from a paper presented at meeting of the *International Acetylene Association*).

Runs Block-Tin Pipe in Steel Pipe, by George Hall.
No. 4. *April*, 1933. *p.* 205.
Specifications for Forest Products Laboratory, Madison, Wis., provided for distilled-water piping to be fully encased in steel piping; how job was done; tees. 1 i.

Oil Refining Process and Piping Explained by World's Fair Model.
No. 7. *July*, 1933. *p.* 340.
Model oil refinery at A Century of Progress. 1 i.

Designing Copper Gaskets for Hydraulic Piping.
No. 2. *February*, 1933. *p.* 88.
Comment on article "Gaskets and Packing for Hydraulic Power" (March, 1932, issue) by J. R. Dilley; F. E. Wertheim, author, replies; plastic properties of copper; compression tests of sheet copper; design of flanged joints; Baumann formula for expressing relations between the variables derived. 1 i.

Novel Control for Operating Pump, by Henry G. Schaefer.
No. 4. *April*, 1933. *p.* 205.
Control for operating pump for emptying blow-off or other closed tank has no float; operation depends on electro-magnet; construction and operation. 2 i.

Piping a Sand-Water Mix, by C. L. Mantell.
No. 2. *February*, 1933. *p.* 87.
Rubber-lined pipe used for filling mine with sand; analysis of the sand pumped; dimensions of the pipe; results. 3 i.

Piping—Refrigeration

How to Save by Modernizing Refrigeration Piping, by R. C. Doremus.
No. 4. *April*, 1933.. *p.* 194.
Check-up of piping pays; two classes of refrigeration piping; match pipe surface to load; allow for all heat items; several room temperatures with one refrigerant temperature; length of piping per coil; too-long piping wasteful; scant pipe surface costs money; curves for pipe ratios in cu ft volume per lineal ft of 2-in. pipe for maintaining various temperatures in rooms with brine and direct expansion systems, and lineal ft of 1¼-in. pipe per ton of ice; tables for sq ft of direct-expansion coil surface per ton per day, brine pipe-coil surface per ton per day, maximum length one coil of ammonia direct-expansion piping, and maximum area indirect brine coil surface per valve. 3 i.

Some Practical Pointers on Modernizing Refrigeration Piping, by R. C. Doremus.
No. 6. *June*, 1933. *p.* 294.
Modernization of piping for conveying refrigerating water and brine; need for piping modernization; examples (ice-cream plant, chemical plant); fluid flow in pipe lines; friction chart for water; chart for brine. 2 i.

Checking up on Refrigeration Piping—Suction and Discharge Lines for Ammonia, by R. C. Doremus.
No. 9. *September*, 1933. *p.* 466.
Effects of increasing suction vapor pressure; effects of increasing discharge vapor pressure; practical limits; vapor velocities; sizing suction and discharge mains (tables); ammonia vapor velocity chart showing velocity range desirable; importance of correctly-sized piping. 1 i.

Brewery-Cellar Piping, by Robert S. Wheaton.
No. 12. *December*, 1933. *p.* 609.
Size of cellars; temperatures required; lay-out of refrigeration coils; typical jobs; arrangement and installation of coils. 2 i.

Hanging Thirty Miles of Brine Piping, by Robert S. Wheaton.
No. 2. *February*, 1933. *p.* 95.
(On the Job); concrete ceiling pitched sharply; engineer's level and rod used for determining length of hangers for ceiling coils. 1 i.

Large Refrigeration Piping Job, by Robert S. Wheaton.
No. 7. *July*, 1933. *p.* 341.
Ten miles of 2-in. piping for cold-storage job; the coils; installation; hook-up for brine coils. 1 i.

Thaws Rink Ice at Saving of $116 and 42 Hours, by Erwin L. Weber.
No. 3. *March*, 1933. *p.* 145.
Ice-thawing system for skating rink in Seattle Civic Arena; economic advantages; the rink; how ice-thawing system was designed; steel shell heater with copper coils heats brine; heat transfer rates, steam to brine; fuel saving. 1 i.

Piping—Steam, Air, Gas (including Steam for Process)

Heat Loss from Copper Piping, by R. H. Heilman.
No. 9. *September*, 1933. *p.* 458.
Transmission of heat from copper tube; emissivity of copper; emissivity coefficients for bare and lacquered copper surfaces at various temperatures (chart); comparison of tests; lacquering to prevent tarnishing increases heat loss; tests made on lacquering; economical thickness of insulation; tables for heat losses from horizontal bare copper pipe, copper tubes, and bare iron pipes. 1 i.

Graphic Solution of Some Common Pipe Bends, by Samuel Kameros.
No. 7. *July*, 1933. *p.* 342.
Charts simplify determination of stresses in pipe bends due to expansion; right-angle bend; simple U-bend; zee bend; expansion U-bend—equilateral type; expansion U-bend—optimum type; examples of use of curves; moment diagram; tables for moment of inertia and section moduli of pipe; linear expansion of steel pipe; modulus of elasticity at different temperatures. 7 i.

Detroit Edison Engineers Present Graphs for Design of Piping for Flexibility.
No. 8. *August*, 1933. *p.* 405.
Outstanding contribution to piping design is paper presented at semi-annual meeting of *A. S. M. E.*: "The Design of Piping for Flexibility by the Use of Graphs," by E. A. Wert, S. Smith, and E. T. Cope; summary of the paper; solution of a typical problem by the method. 3 i.

Expansion, Set of 400-Lb Piping Are Studied, by W. P. Palmer.
No. 3. *March*, 1933. *p.* 142.
Means provided for studying expansion and set of 400-lb, 750 F steam piping in power plant; results of study and movement of piping tabulated; rugged support takes care of piping vibration; anti-vibration support for boiler-feed piping. 3 i.

G. E.'s New Piping for 400-Lb 750-F Service Electric-Arc-Welded Throughout, by Robert Daniels.
No. 7. *July*, 1933. *p.* 354.
Steam piping system for conveying steam for heating, turbine-testing, and manufacturing from new mercury-steam-electric generating system at Schenectady, N. Y.; the plant; steam and return lines in tunnels; 14-in. seamless piping; installation of expansion joints; two types of pipe-carrying bridges; distribution of steam; insulation of lines; erecting pipe in tunnels; welding data and costs; regular production welders used. 8 i.

Industrial Piping Systems Pay Modernization Dividends, by A. W. Moulder.
No. 1. *January*, 1933. *p.* 3.
Life of piping limited; piping materials available; welding and welding fittings; supports; recent modernization of piping shows possibilities; 10 specific cases; old large piping replaced, heat loss cut; new overhead main installed; several deteriorated systems replaced; process hot water supplied economically; process and heating condensate returned to boilers; saves thousands on fuel by arranging for burning wood wastes; pipes spring water for air conditioning; replaces depreciated boilers, piping, etc.; old pipe coils taken out, unit heaters and controls put in. 5 i.

$750 for Piping Change Cuts Fuel Bill $2,300, by W. C. Gould and Francis A. Westbrook.
No. 1. *January*, 1933. *p.* 14.
Changes in piping, installation of pressure regulators, etc., cut cost of fuel for generating heating and high pressure steam at Beth Israel hospital, Boston, Mass.; factors influencing fuel saving; unaflow engine used for reducing steam pressure cuts power cost; arrangement of piping. 2 i.

Selection of Pressure Regulators, by Harold L. Colby.
No. 11. *November*, 1933. *p.* 565.
Over-sizing of pressure regulators: example; limitations of piping arrangement; choosing control point; preventing cutting action of condensate; general suggestions. 4 i.

Experts Discuss Valve Installation.
No. 2. *February*, 1933. *p.* 97.
(On the Job); comments and notes on installation of globe and angle valves in steam piping by J. B. Gibson, J. P. Ferguson, F. B. Corey, A. M. Houser and W. H. Wilson. 5 i.

Improved Piping Arrangement for Operating a Damper Regulator, by W. H. Wilson.
No. 5. *May*, 1933. *p.* 248.
Damper regulator controlled by steam pressure for controlling draft in furnace of boiler; location of connection to damper regulator; the piping. 1 i.

Forget Expansion; Trouble Results, by Bernard Kramer.
No. 3. *March*, 1933. *p.* 149.
(On the Job); nozzle on gas cooler cracks; cause; remedy; nozzle on gas reheater snaps off; cause; remedy. 2 i.

Modernization

(More specific articles on modernization will be found under the other headings.)

Modernization—An Opportunity for Savings and Profit.
No. 1. *January*, 1933. *p.* 1.
Modernization is good engineering; opportunities in air conditioning; real economies are possible in heating; the modernization of industrial piping pays; if modernization pays, modernize; how to plan for modernization.

Include in $3,300,000,000 Public Works Program the Modernization of Mechanical Equipment in Existing Properties.
No. 9. *September*, 1933. *p.* 450.
The plan, proposed by Russell Grinnell, and its advantages; proof of the soundness of the plan given by examples of specific properties by consulting engineers (Samuel R. Lewis, Walter E. Gillham, and Alfred Kellogg.

Public Works Modernization—Get Consulting Engineers on the Job.
No. 10. *October*, 1933. *p.* 497.
Need for facts on specific projects to get action; industry must take initiative; survey must be made; consulting engineers can do it; recovery act provides for modernization; modernization meets tests; set-up of Public-Works Administration; it is up to the industry.

Public Works Modernization Plan; Proper Effort Now Should Put It Over.
No. 11. *November*, 1933. *p.* 545.
Status of public works modernization plan; telegram from General Hugh S. Johnson on recovery of capital-goods industries; consulting engineers report modernization opportunities (specific examples reported by C. E. Daniel, C. P. Lichty, Wm. K. Robertson, Elliott Lee Ellingwood, F. H. Valentine, Perry West, and Dwight D. Kimball).

National Industrial Recovery Act Codes Indicate Need for Modernization.
No. 8. *August*, 1933. *p.* 393.
Many opportunities for modernization in heating, piping and air-conditioning services; should be considered by every plant executive.

Suggests Recovery Act Funds Be Used to Abate Smoke Nuisances.
No. 8. *August*, 1933. *p.* 401.
Memorandum by H. C. Murphy suggests use of federal funds to modernize plants and buildings to abate smoke nuisances; suggests municipal action.

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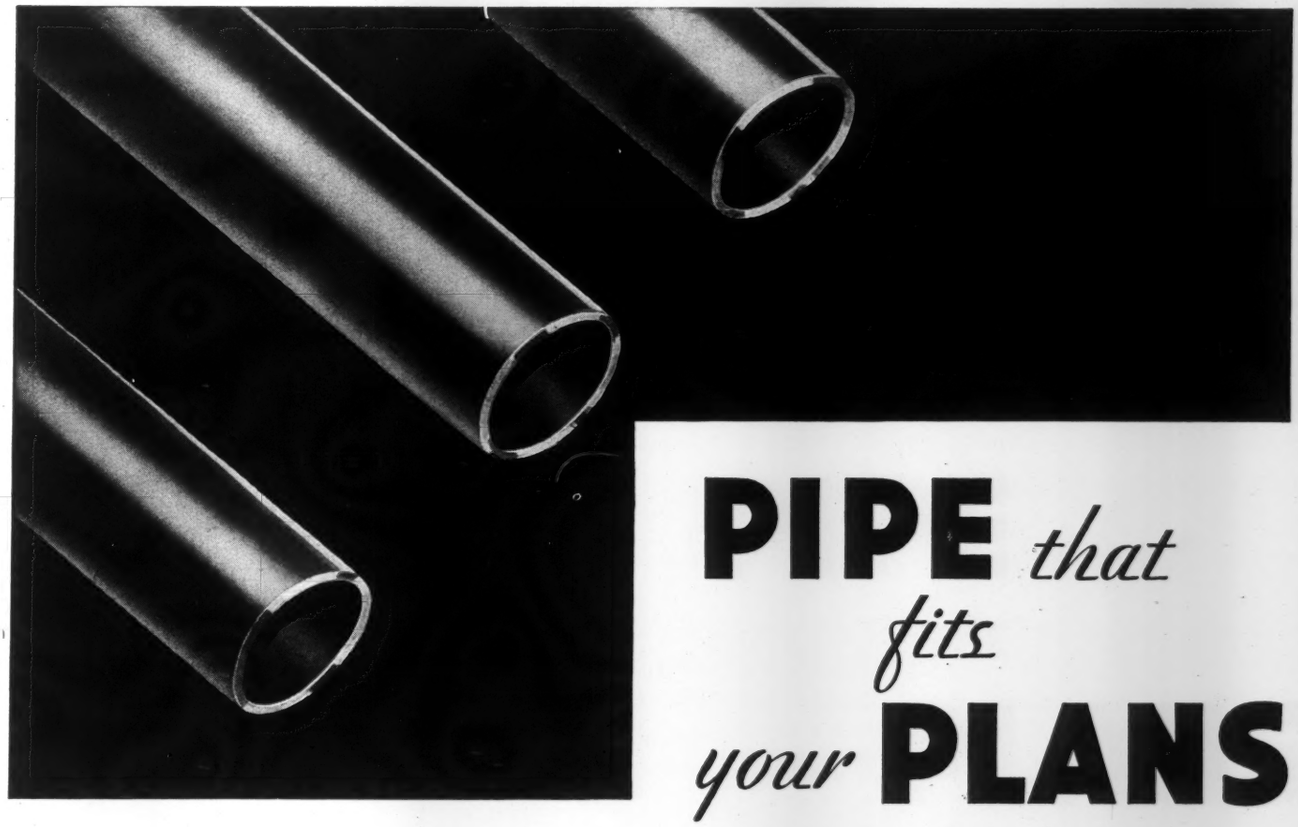

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- ✓ *Resistant to corrosive influences.*
- ✓ *Made from superior quality Open Hearth steel.*
- ✓ *Complete range of sizes, wall-thicknesses and lengths.*
- ✓ *Readily adaptable to any type of joint.*
- ✓ *Proved performance under exacting service.*
- ✓ *A product of the largest manufacturer of Seamless Pipe.*

America's Preferred Seamless Pipe

NATIONAL TUBE COMPANY · Pittsburgh, Pa.

Subsidiary of United States Steel Corporation

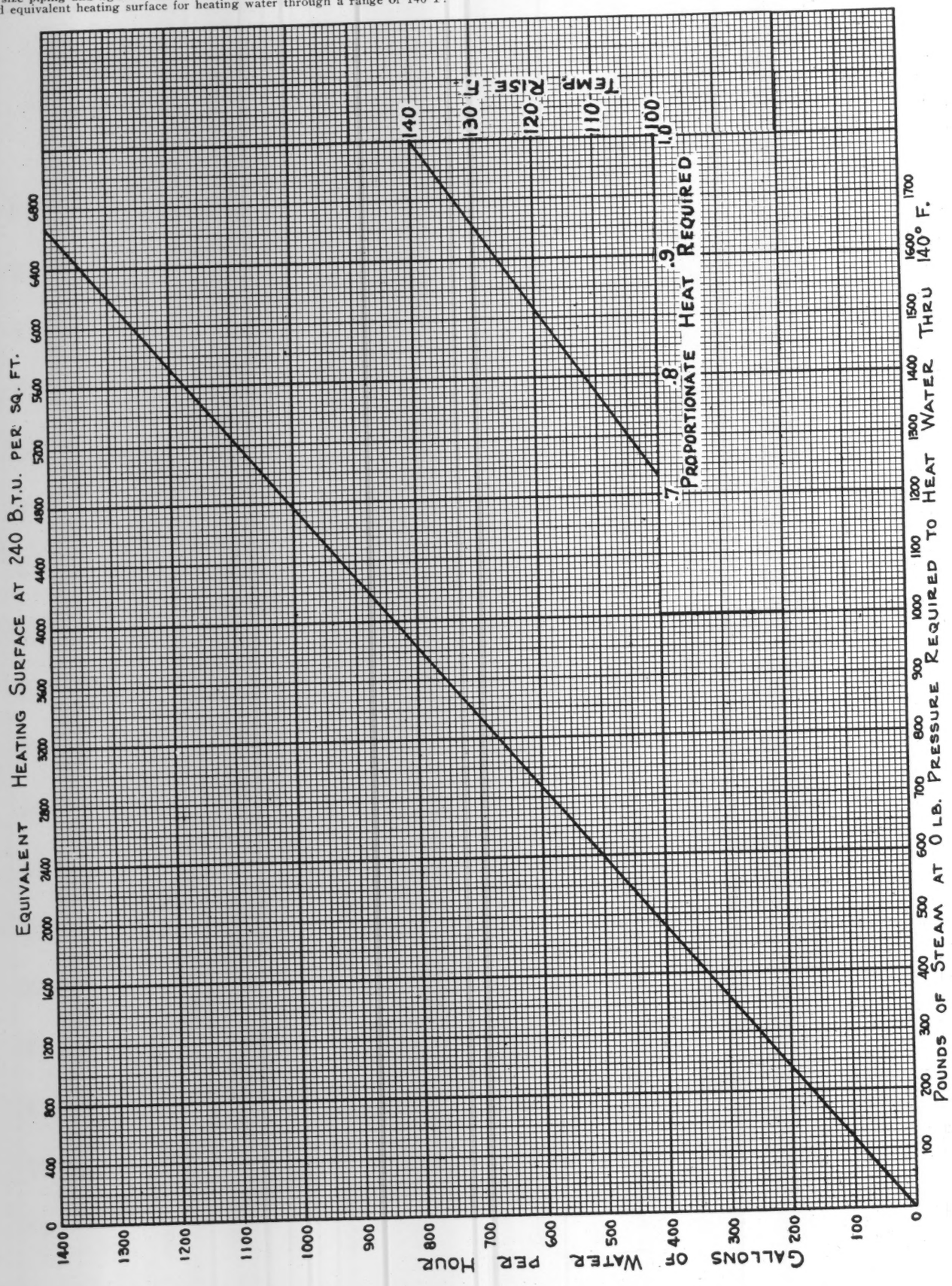
NATIONAL SEAMLESS

PIERCED FROM SOLID BILLETS-NO WELDS

Steam Required for Water Heating 9

. . . . by Price L. Rogers, Consulting Engineer, Philadelphia, Pa. In computing radiation for buildings, it is also necessary to determine how much steam is required for heating water for domestic services in order to size piping and figure boiler load. This chart gives both steam required and equivalent heating surface for heating water through a range of 140 F. The small curve shows the proportionate heat required for other temperature ranges.

The first chart in this series was published in April, 1932, with an explanation and example of the use of the series.



"HITHERTOS"

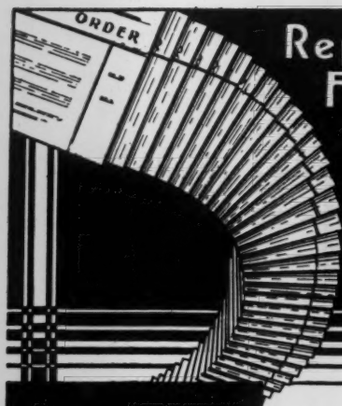
are passing out

Throughout industry "hithertos" are dying fast. Precedent, nowadays, is more handicap than help. Above all is this true in the heating, ventilating, air conditioning profession, industry and trade.

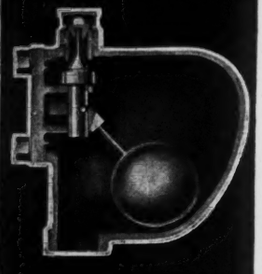
Changes during the past two years have been phenomenal. Methods new a year ago are already obsolete. New equipment, appliances, methods, materials, accessories, tools, instruments and supplies are revolutionizing the field and opening unmeasured opportunities for those who keep up to date.

A panorama of progress—an Exposition at which you can view, examine, question and compare—the INTERNATIONAL HEATING & VENTILATING EXPOSITION—invites you to tune in with the times and equip yourself for alignment with those who can profit in and through this rich field.

138



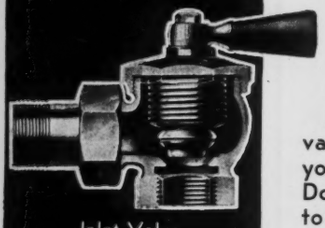
Repeat Orders For 31 Stores Received from S. H. KRESS & Co.



Air Eliminator

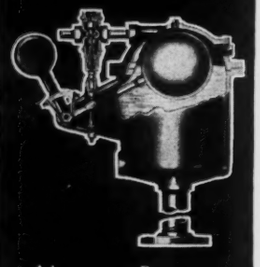
One time sales are common—but shrewd buyers do not purchase a second time unless a product makes good.

S. H. Kress & Co., the masters of organization who operate stores all over the country, investigated the claims made for the Sarco Heating System years ago and put in their initial installation. The Sarco made good; so good, that since then they have installed it in 30 additional stores in different parts of the country.



Inlet Valve

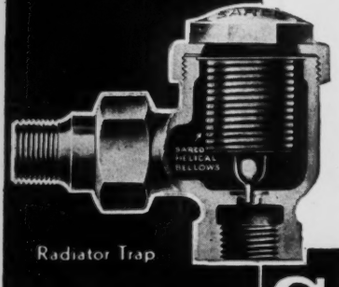
Isn't the experience of this vast organization worthy of your serious consideration? Don't you owe it to yourself to find out something about this modern heating system that has won the unqualified confidence of these shrewd, farseeing business men?



Alternating Receiver

The greatest advertisement for the Sarco Heating System has always been the recommendation of enthusiastic buyers.

Write for free memo. book and our interesting catalog 0-45.



Radiator Trap

SARCO CO., Inc.,
183 Madison Ave.,
New York, N. Y.

Branches in Principal Cities

Sarco Canada Limited,
Federal Bldg., Toronto, Ont., Canada

SARCO Heating System

Conventions and Expositions

National Warm Air Heating and Air Conditioning Association: Annual convention, December 4-6, Netherland Plaza Hotel, Cincinnati, Ohio. Managing Director, A. W. Williams, 50 W. Broad St., Columbus, Ohio.

Chemical Industries Exposition: December 4-9, Grand Central Palace, New York City.

American Society of Mechanical Engineers: Annual meeting, December 4-8, New York City; headquarters, 29 W. 39th St. Secretary, Calvin W. Rice, 29 W. 39th St., New York City.

American Society of Refrigerating Engineers: Annual meeting, December 6-8, Hotel New Yorker, New York City. Secretary, David L. Fiske, 37 W. 39th St., New York.

Joint Meeting, Air Conditioning in Industry: Popular forum on air conditioning sponsored by *A.S.M.E.* and *A.S.R.E.* during meetings of the Societies in New York, first week in December.

American Society of Heating and Ventilating Engineers: Annual meeting, February 5-8, New York City, Secretary, A. V. Hutchinson, 51 Madison Ave., New York City.

International Heating and Ventilating Exposition: Third exposition, February 5-9, 1933, Grand Central Palace, New York City. Charles F. Roth, Manager, International Exposition Co., Grand Central Palace, New York City.

American Oil Burner Association: Convention and oil-burner show, March 5-9, Commercial Museum, Philadelphia, Pa. Headquarters office, 342 Madison Ave., New York City.

German Work on Industrial Heat Transfer Translated

"Industrial Heat Transfer," by Alfred Schack, has been translated from the German by Hans Goldschmidt and Everett P. Partridge, and recently has been published by John Wiley & Sons, Inc., New York City. (371 pp., 6x9, price, $5.00.)

In the author's preface, it is stated that this book is chiefly the result of some seven years' work at the heat institute of the *Verein Deutscher Eisenhüttenleute.* Particular consideration has been given to the needs of the practicing engineer, special emphasis being placed on the development of equations which would be simple in form without sacrificing exactness. Where it was not possible to develop simple equations, charts have been prepared to allow the convenient reading of desired values.

The translators (faced not only with the problem of transmuting technical German into technical English, but also replacing the metric system with English units) have done a most thorough job. More important equations are distinguished from the rest by a star. Equations which have a restricted value or are later superseded have an explanatory note to aid the reader in finding quickly the best solution for his problem. It is the belief of the translators that no more detailed derivations of heat-transfer equations will be found in any other book in the English language.

The book is excellently arranged for practical use, containing sections on nomenclature, important physical constants, conversion factors, a listing of literature cited, etc. Not the least useful section is a compilation of the most important equations for heat transfer. The contents includes sections on the three ways in which heat is transferred and surface conduction, analysis of the three mechanisms for heat transfer (conduction, convection, heat transfer from condensing vapors, radiation), calculations for heat exchangers, heat transfer in industrial furnaces, heat transmission and pressure drop, and numerical examples in heat transfer. In this section, practical examples involving the most important types of heat-transfer problems are completely calculated to enable the beginner to make ready use of the book.

Preventing Algae Growth in Condensers

THE WRITER would like to know how chemically to treat water used for condensing purposes to prevent or reduce the formation of algae or vegetable growth.

The system in question consists of a horizontal closed shell-and-tube condenser with ¾ in. O.D. tubes and an atmospheric cooling tower. During summer weather, when this water gets up to 85 to 95 F, an algae growth forms rapidly in the tubes and on the tower. What chemical may be safely used with Admiralty metal tubes, and in what quantities and how often should it be added to keep down this growth which greatly reduces the efficiency of the condenser, necessitating shut-downs about every two to four weeks?—W. B. C.

Answer: Algae, vegetable, and fungus growths have been the cause of annoyance, expense and outage, not only where condenser water is taken from rivers, but also in plants where water is recirculated by means of spray ponds or cooling towers. Where river water is used the slime usually acts as a binder for mud and silt, the worst conditions obtaining in summer because the development of algae increases enormously with higher temperatures.

Mechanical methods of cleaning condensers, such as back-washing, shooting metal or rubber plugs through tubes, and boiling out water surfaces of condensers with soda-alkali solutions are familiar to operating engineers. These methods, however, are not as satisfactory as the chemical process of chlorination in dealing with gelatinous deposits.

Chlorination of condenser water to prevent growth of algae, either for systems with down-stream discharge or for recirculating systems, has been established as a commercially-successful process by nearly ten years of trial. Ordinarily, an increase of vacuum of about 0.22 in. Hg will result from clean tubes, and condensers can be kept in service for long periods. The savings in fuel and labor cost are more than sufficient to pay for chlorine and for the other charges involved.

This process consists in feeding liquid chlorine into the pump suction, thorough mixing of chlorine and water resulting from the turbulence of the pump. Chlorine is injected until there is a certain residual content in the water, after which intermittent chlorination is not only sufficient, but produces superior results.

A brief outline of the experiences of two plants will serve to illustrate the foregoing statements:

Plant *A* has a total capacity of 6100 kw, with a maximum circulation of 5500 gpm from a spray pond through the condenser system. A chlorinator with maximum capacity of 50 lb per day was installed. Results: Chlorinator was set to inject very much less than 50 lb per day, growths were prevented, and outage was stopped.

Plant *B:* Here polluted river water with maximum temperatures of 70 to 80 F was passed through 1-in. Admiralty tubes in a 50,000 sq ft condenser, at velocities of 9 to 10 fps. It was necessary to clean tubes once a week with rubber plugs during the summer. After chlorination there was a gain in vacuum; and tube cleaning, boiling out condenser, and outage were eliminated. The maximum amount of chlorine necessary was 75 lb per day over a 90-day period (for maximum temperatures), while the minimum was 40 lb per day over a 120-day period.

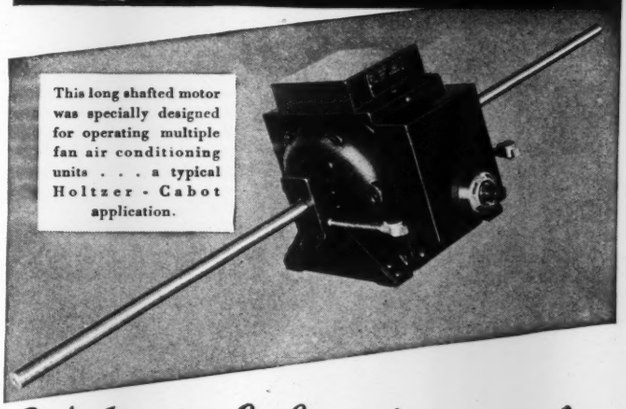
In neither plant was there deterioration of condenser tubes or pump runners; in fact, the amount of chlorine used is too minute to cause damage. One very large plant now uses a dosage of 2½ ppm of chlorine, injecting the liquid 4 minutes out of every 40, to prevent slime from river water polluted with sewage, which attains temperatures of 67 to 76 F.

Success of this process is absolutely dependent upon complete control of the chlorine, because its escape will damage equipment and is a hazard to workers. Chlorination apparatus is simple, but it represents a long period of research. It should be installed only by experts.—F. E. WERTHEIM.*

*Mechanical Engineer, Chicago, Ill.

Air Conditioners!

3 frank questions



This long shafted motor was specially designed for operating multiple fan air conditioning units . . . a typical Holtzer-Cabot application.

We'd like to ask..

1 Are you having any trouble with motor noises?

2 Does your present motor in any way restrict the utmost efficiency of your product?

3 Have you sacrificed attractiveness of design merely to accommodate your product to some standard built motor?

If so . . . we'd like an opportunity to sit down and talk things over. For over forty years, engineers of The Holtzer-Cabot Electric Company have been making custom built motors to meet all types of fractional horsepower application. For example, the long shafted air conditioning motor illustrated above.

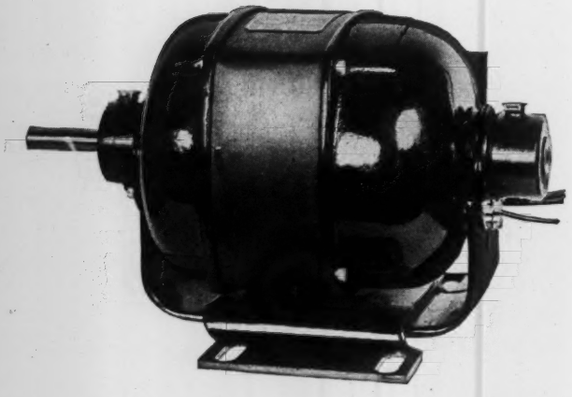
Custom built motors quickly pay for themselves in lowered maintenance costs. Moreover a "built for the job" motor can emphasize any desired need. In designing your next season's model, why not let us show you what we can do? You may find our suggestions very much worthwhile.

The HOLTZER-CABOT ELECTRIC CO.

125 AMORY STREET

BOSTON, MASSACHUSETTS

Fractional Horsepower Motor Specialists



BACKED BY PERFORMANCE

The Leland repulsion-induction motor for stoker, oil burner and air conditioner applications is not "just another motor"—this ad "just another advertisement" or the Leland salesman "just another salesman." All are backed up by performance, the motor speaking for itself more convincingly than words.

Specially Mounted and Unusually Quiet

Now available: a new resiliently supported flange mounting that minimizes and virtually eliminates motor noise and vibration—that overcomes tendencies toward shaft misalignment, significant when direct connected—that may be used either vertically or horizontally with equal effectiveness.

Various Designs

This motor is available in both ventilated and enclosed construction. It may be fan cooled to meet abnormal temperature conditions.

Glad to forward for comparison any Leland motor in which you may be interested.

A. C. Repulsion-induction
D. C. and polyphase
Split phase
Interchangeable frames
Specials where required

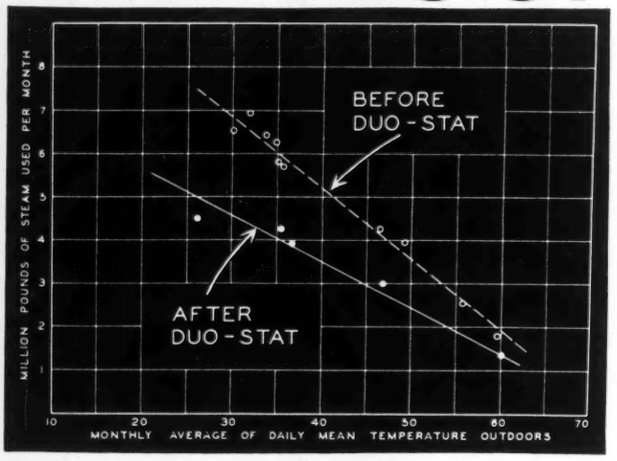
The LELAND ELECTRIC *Co.*
DAYTON · OHIO · U·S·A

CANADIAN ADDRESS
TORONTO

CABLE ADDRESS
LELECT

KONTAX MERCURY TUBES
Leland Motors
MERCURY TUBE CONTROLS

Another PROOF



—*an accurate picture of* DUO-STAT SAVINGS *in the* HEARST BUILDING of Chicago

IT was even more than we had hoped for! In exactly six weeks the Raymond Duo-Stat in the Hearst Building, Chicago, had *paid* for itself. The story of this big cut in steam costs is shown above in the simplest possible way—by simply plotting steam used per month against the daily mean temperature outdoors.

If this were the only record of its kind you would have a right to question it. But the record of the Hearst Building is merely one leaf of a great volume of evidence for the Raymond Duo-Stat. We have charted many of these records in the same way that the Duo-Stat record in the Hearst Building is pictured above. Have you received a set of these charts?

What would the picture of Duo-Stat savings be in the building, or buildings, in which you are interested? We will gladly chart this for you if you will simply supply a record of steam or fuel consumption (by months) for the last year. We have prepared many charts of this kind, and the theoretical steam saving that they show has invariably been exceeded by actual performance in those cases where the Duo-Stat was later installed.

F. I. RAYMOND CO.
629 W. Washington Blvd.
CHICAGO, ILL.

The DUO-STAT *alone combines these features* ●

- Controls room temperature by a combination of outside and radiator temperature. (A fully protected principle.)
- Is just as effective with one-pipe system as two-pipe system.
- Accomplishes partial filling of radiators in either a one-pipe or two-pipe system.
- Cannot be upset by open windows.
- Gives a modulated control that can only be described as Duo-Stat modulation.

RAYMOND DUO-STAT

Pitting of Boiler Tubes

I WANT some information regarding the pitting of tubes in a steam heating boiler. The tubes had only been in a few years but had to be replaced.

The heating system uses an electric-driven vacuum pump and receiver for returning the condensate to the boiler. The return is higher than the steam main and lift fittings are used to elevate the condensate from the steam mains. As I see it, dissolved oxygen is brought into the condensate by the high vacuum required to lift the condensate and this returning to the boiler untreated causes the corrosion and pitting.

Can you advise of any treatment that will stop pitting of this kind and what method of testing the water may be used to determine if the condition is active or not?—L. J. K.

Answer: Fundamentally the correct first step is to have the condensation water analyzed. The collection of a sample and its analysis, however, is a very technical sort of task (see bulletin of the *National District Heating Association* on "Standard Methods for Sampling and Analyzing Steam and Condensate in Corrosion Test Studies"). In all large cities there are commercial chemists equipped to make such an analysis for a reasonable fee.

Something in the water is eating up your boiler tubes. Equipment which furnishes a reasonably sure deterrent to ordinary corrosion due to excess oxygen and carbon dioxide is available; the device is called a surface deactivator. It consists of a tank in which metallic and easily-digested "food" to satisfy the eating proclivities of the corrosive water is placed, so that, thus being sated, the boiler tubes shall be less tempting. Maintenance of this device is low in cost or trouble.

In making inquiries of manufacturers of such equipment, the approximate number of gallons of water circulated per hour should be stated; also the boiler pressure, which is deduced to be less than 5 lb, and the temperature of the return water, which is deduced to be around 180 F. The amount of outside water taken in may have a very important bearing on the matter.

The writer knows of one particularly incompetent laborer in charge of a stoker-fired heating boiler who neglected a leaking return, permitting the boiler to be fed by the automatic water feeder. He also neglected the blow down to such an extent that when his incompetency was discovered the blow-off piping was completely stopped with accumulated solids from the water. There have been cases where the use of rain water, undiluted by a fair mixture of lime-bearing water, caused boiler tubes to be eaten out quickly. The chemical analysis suggested would disclose such a condition. There have been cases in which vagrant electric current accounted for electrolytic action on the boiler. Zinc plates in the boiler are used successfully in naval practice to discount this trouble.—SAMUEL R. LEWIS.*

*Consulting Engineer, Chicago; and Member of Board of Consulting and Contributing Editors.

Harrisburg Makes Steel to Suit the Product . . . .

A high quality steel product can only be produced from steel of correct basic analysis. That is why Harrisburg makes its own steel. Because, as a result, our Metallurgical Department is able to supervise the open hearth furnaces, such as the one being tapped above, so that each heat of steel meets the metal specifications required by the Engineering Department for each particular product. That's one reason why engineers the nation over are able to depend on these famous Harrisburg forged and seamless steel products: Steel Pipe Flanges; Drop and Hollow Forgings (to order); Seamless Steel Cylinders, Pipe Couplings, and Bull Plugs; Pipe Coils and Bends.

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HARRISBURG PIPE & PIPE BENDING CO. Harrisburg, Pa.

Chicago's Great New Post Office

AEROFIN

Fan Blast Heat Surface

Installed Throughout

Universal Aerofin

AEROFIN, the original, modern, scientific Fan System Heat Surface, was chosen by Architects, Graham, Anderson, Probst & White, for Chicago's great new Post Office Building and installed under the general contract of John Griffiths & Son Company by H. P. Reger & Company, heating contractors.

AEROFIN won out again, as in hundreds of installations, because of superior design and workmanship and for its exclusive features.

Whatever you've wished for in a Fan System Heat Surface, you'll find in AEROFIN. Send for catalogue to the address below.

Flexitube Aerofin

AEROFIN
is sold only by Manufacturers of Nationally Advertised Fan System Apparatus.
—
List upon Request

AEROFIN CORPORATION
850 Frelinghuysen Avenue
Newark, N.J.

Chicago Detroit New York Philadelphia

[*From page 610*]

mostatic return trap and union connection integrally in the other header.

The combination of these elements in a single unit is stated by the manufacturer to reduce materially the cost of installation by simplifying piping connections. The heating element instead of being horizontal or vertical is inclined at an angle, which is designed to provide maximum heat output per unit of space occupied.

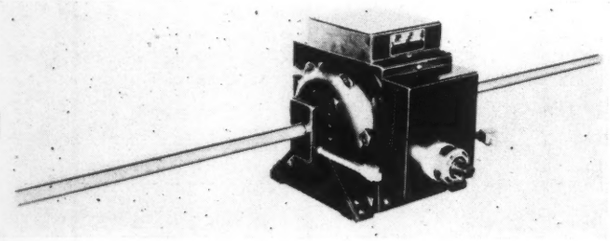
Enclosures are included with the radiators in all cases and are obtainable in a choice of plaster front, metal front, tile front and cabinet units. All enclosures are so designed that the entire heating element may be removed without difficulty through the lower grille or opening after installation.

A wide range of sizes is available. A catalog containing complete description, dimensions, ratings and suggested specifications is available.

Long Shafted Fractional Hp Air-Conditioning Motor

Equipped with an extremely long shaft for operating multiple fan units in air-conditioning apparatus, a new low-speed fractional-horsepower motor recently announced by The Holtzer-Cabot Electric Company, Boston, Mass., is intended to make possible an efficient design of the fan unit.

The motor is a special, quiet-operating, adjustable, varying

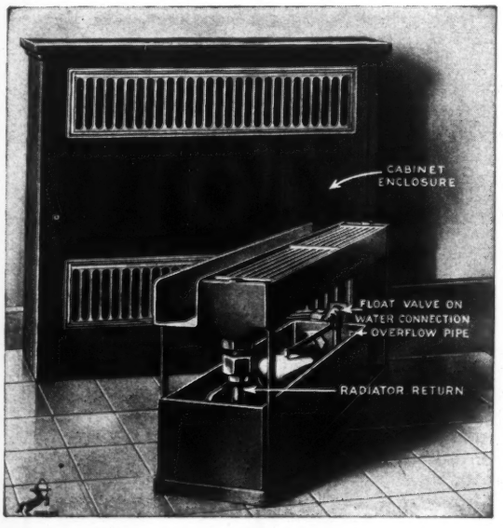


speed, single phase a-c capacitator type with resilient mounting designed to maintain the shaft in a fixed position. An all-metal resilient base that retains its efficiency indefinitely is provided.

The motor has wool-packed bearings that require only infrequent lubrication and attention, according to the announcement. Motor and control apparatus are self-contained.

New Humidifying Radiator

The proper degree of moisture for humidifying a room is obtained automatically by means of a new humidifying radiator, according to the manufacturer, the Chase Brass & Copper Co.



Eighteen "Buffalo" No. 6-E Blowers on one shipment to a large oil company.

fans for INDUSTRY

Unit Heaters

Unit Coolers

Air Washers

Fans
Ventilating
Exhaust
Cooling
Power Plant
Rubber Lined

Dryers
Drum
Conveyor

Fan equipment for industrial use MUST have three characteristics if it is to be accepted. It must be efficient, it must be sturdy—it must require little attention in operation.

Thousands of Buffalo Fans in industrial plants live up to these three requirements. Buffalo engineers design fans to fit the service. That they know how to do this is evidenced by the wide industrial acceptance of our handbook "Fan Engineering," now in its third edition. For each of the hundreds of applications in industry there is a Buffalo Fan which will give very satisfactory service.

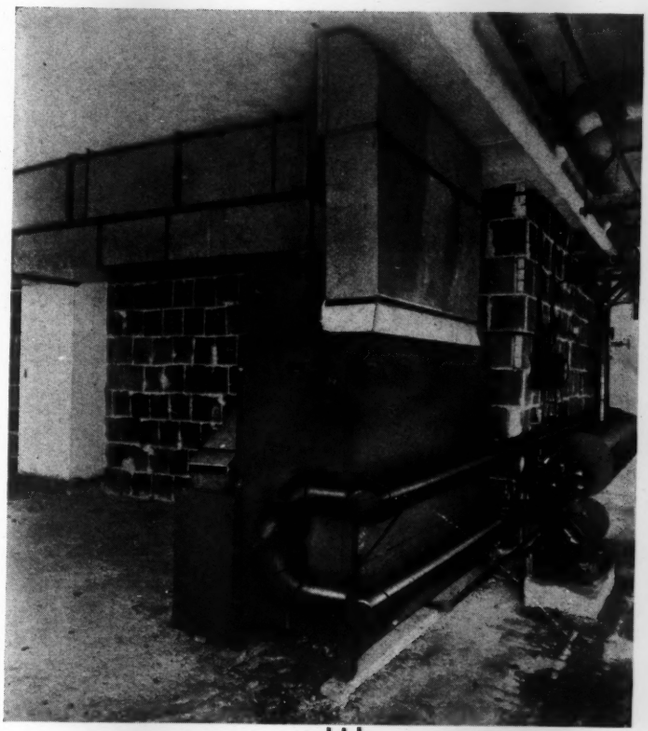
Consult Buffalo Engineers

When you have an air- or gas-handling problem, consult the engineers recognized as authorities on selection of fans. No charge—no obligation.

Branch offices in all principal cities.

Buffalo Forge Company
171 Mortimer St., Buffalo, N. Y.
In Canada: Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

"Buffalo" *for* HEATING VENTILATING AIR CONDITIONING



Air-conditioning equipment, Thompson Restaurant Co., St. Louis, Mo. Ducts and pipe covering Corinco insulated

More and More **COMPANIES** *Select* **CORINCO INSULATION**

An ever-increasing number of leading companies are using Corinco for the insulation of their air-conditioning systems. And to this growing list is included the Thompson Company Restaurant, St. Louis. Such broad acceptance of Corinco Insulation is nation-wide . . . the result of perfect materials scientifically manufactured and erected.

A Corinco Engineer in your Territory will gladly confer with you, without obligation. We invite your inquiry.

Attach coupon below to your letterhead for illustrated Catalog.

CORK INSULATION CO., INC.
125 EAST 42nd STREET NEW YORK, N.Y.
BRANCHES IN LEADING CITIES

FACTORY: WILMINGTON, DELAWARE
Manufacturers of Corkboard, Cork Pipe Covering and Granulated Cork

Please mail catalog to

Company .....
Name .....
Address .....

Have *Your* Steam Traps Stood the Test?

WHEN the going has been tough, have your steam traps met every requirement? Have they piled up annoyance, expense and waste or have they built a record of dependable service with little cost and trouble on your part?

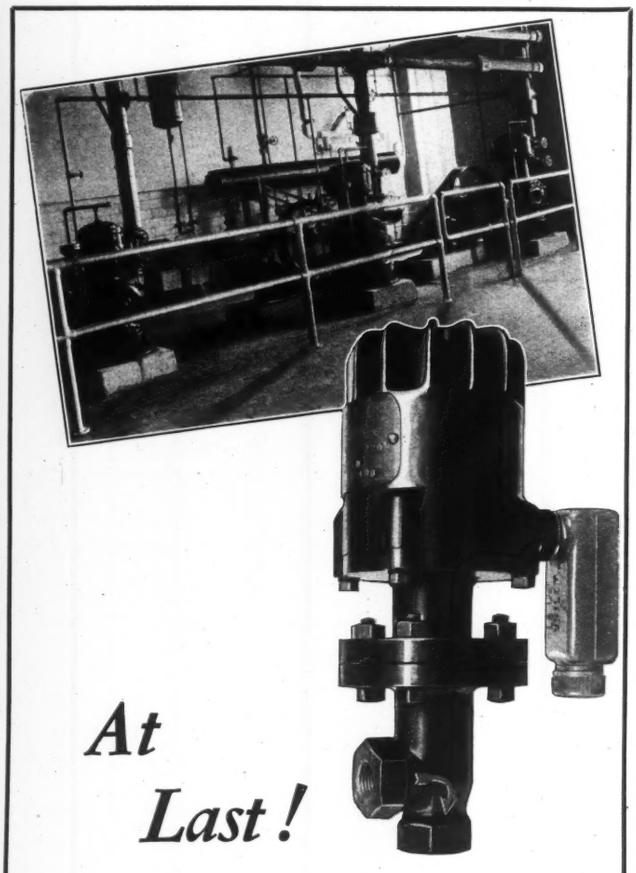
Armstrong Steam Traps have come through severe tests for more than 20 years. They have saved money and have speeded up heating and processing for thousands of leading users.

You can enjoy "complete satisfaction" in steam trap service—the Armstrong guarantee—by selecting an Armstrong trap for every need, by utilizing the Armstrong service organization to the fullest extent, and by judging traps on the basis of performance and not on such false standards as pipe sizes or cost per pound.

Your nearest Armstrong representative will welcome an opportunity to help correct any troubles you have had with traps and to put one or more Armstrongs at your service for 90 days free trial.

ARMSTRONG MACHINE WORKS
874 Maple Street
Three Rivers, Michigan

HP&AC 12 Gray



At Last!

A Reliable Packless Electric Control Valve for Refrigerating Plants

Frick Electric Control Valves fill a need long felt among engineers for a frost-proof valve that can be used as a shut-off under electric control from a thermostat or relay, in either the liquid or suction lines of automatic refrigerating plants having two or more rooms. Unsurpassed also for unloading compressors during automatic starting. Quick acting, full opening, tight closing, sturdy, positive. Get full data on these remarkable Control Valves. Write, wire or phone NOW.

Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882

Branch Offices and Distributors in 85 Principal Cities

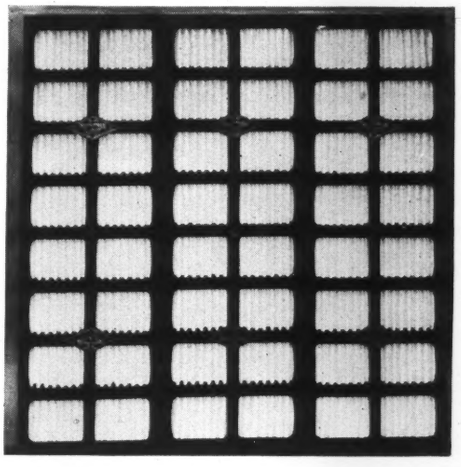
(Erskine Radiator Division), Waterbury, Conn. It is a combination of copper radiator and a humidifying device for use with steam heating systems.

The moisture is added to the air before heating to insure against any approach to saturation of the air which would tend to precipitate moisture upon coming into contact with cooler surfaces in the room. The moisture is supplied by using heat that would otherwise be wasted, according to the announcement, which also states that this patented feature eliminates sprays and insures the proper amount of moisture for a given temperature. The radiator can be installed in an attractive cabinet against the wall. It can be completely recessed in the wall or, it can be installed below the floor level.

Announces New Air Filter

A "multi-V-type" air filter has been announced by the Staynew Filter Corporation, Rochester, N. Y. The multiple-V arrangement of the unit is designed to allow maximum amount of filtering surface in the minimum space. A dry fabric type filter medium is used, made of closely-pressed cotton fibers distributed on both sides of a non-metallic, gauze-like center. Cell depth is 1 in.; cell frame is of fiber board. Metal reinforced fiber-board fingers maintain uniform spacing of the "V" pockets.

A recently-issued bulletin describes this new filter in detail and shows a variety of arrangements for different purposes. It is stated that the filter medium itself, when clean, will accommodate 40 cfm per sq ft at 0.06 in. w.g. pressure drop; the large-capacity units are rated conservatively, it is stated, to permit sustained operation. For industrial ventilation work it is suggested that each sq ft of filtering surface accommodate 20 to 25 cfm, and for dust recovery service, 5 to 10 cfm.



The illustration shows an assembly of cells as used in the four-square-foot unit.

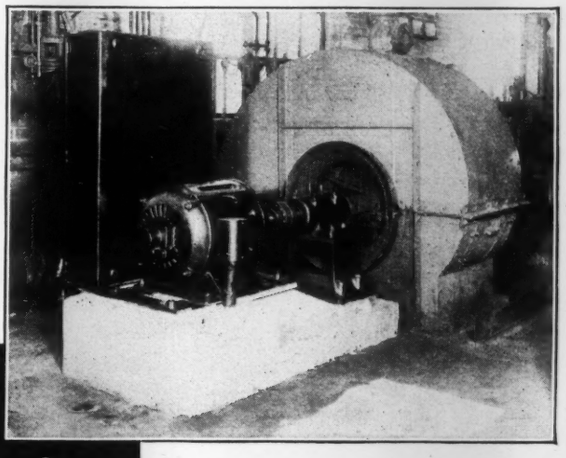
The cells are cleaned by means of a portable vacuum cleaner.

Pyrometer Has Novel Design Features

A new unique type of balancing mechanism is one of the features of the new recording potentiometer pyrometer designed and manufactured by the Foxboro Company, Foxboro, Mass. This balancing device is so designed that it produces a large movement of the pen or print wheel for a small galvanometer deflection and moves the printing mechanism from one end of the scale to the other in a minimum of time, without requiring an extremely fast cycle or rapid motion of the mechanism, according to the maker's announcement. The balancing mechanism consists essentially of a V-shaped drive cam and a friction roller.

The sensing fingers, which detect galvanometer deflection, position the friction roller according to the position of the gal-

Multi-Speed Motors for fans



2 SPEED

3 SPEED

4 SPEED

CONSTANT TORQUE

CONSTANT H P

VARIABLE TORQUE

PICTURED above is a Wagner multi-speed motor driving a forced-draft fan in the boiler house of a large drug company. It is a 25/11/6.2 horsepower, 1725/1140/860 rpm variable-torque type MRP-1 motor.

When it's a multi-speed motor application—consult Wagner. 2-speed, 3-speed, or 4-speed—constant-torque, constant-horsepower, or variable-torque—open frame, drip-proof, or totally-enclosed fan-cooled—horizontal or vertical—sleeve or rolling bearing—½ or 125 hp—whatever the motor requirement may be, there's a Wagner multi-speed motor designed and built for the job.

The motor illustrated above as well as other types of Wagner multi-speed motors, is described in Bulletin 174. Ask for a copy.

WAGNER ELECTRIC CORP.
MOTORS TRANSFORMERS FANS BRAKES

WAGNER ELECTRIC CORPORATION,
6370 Plymouth Ave., St. Louis, U. S. A.

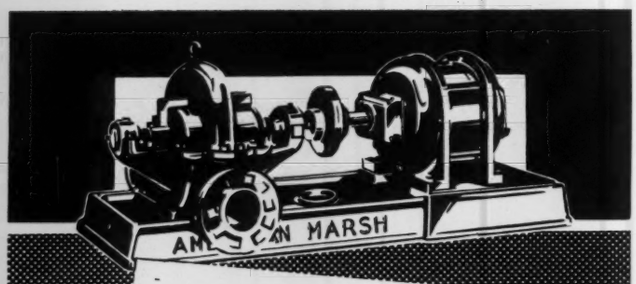
Please send literature on multi-speed motors.

Name and Position

Firm

Address

M333-1



WHEN you select American-Marsh Pumps, you are dealing with an organization that was serving industry long before the "Gay Nineties"—an organization that builds pumps and pumps only. This wealth of experience, and this concentration of every effort upon one and only one product, have made for preeminence in the pump field. American-Marsh Pumps are as fine as your money will buy anywhere. The line is complete. Your inquiry is invited. AMERICAN STEAM PUMP COMPANY, Battle Creek, Mich.

AMERICAN-MARSH PUMPS
CENTRIFUGAL AND STEAM

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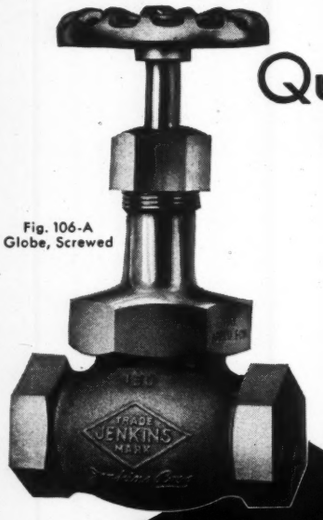

Fig. 106-A Globe, Screwed

Quality pays even today

There is QUALITY in Fig. 106-A Jenkins Bronze Globe Valve ...extra deep stuffing box...slip-on stay-on disc holder...one-piece screw-over bonnet...Jenkins Disc.

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Bridgeport, Conn., Boston, Mass.
Chicago, Ill., Philadelphia, Pa.

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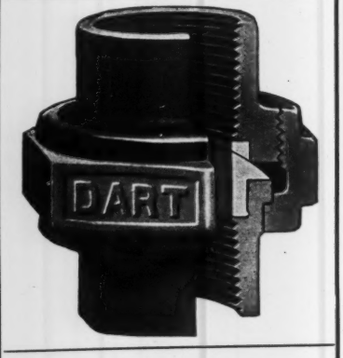
BRONZE IRON STEEL
VALVES
Since 1864

Always marked with the "Diamond"

☆ DART ☆

LEAK PROOF



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BECAUSE their TWO BRONZE SEATS protect the joint from corrosion and because the ball seat is accurately ground to fit, Dart Unions are absolutely leak-proof. Reliable Dart Unions are your best bet on the most difficult installations. Specify Darts every time.

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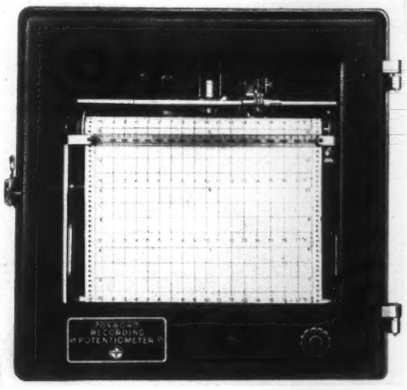
THE Minneapolis-Honeywell Modutrol System, with the Modustat automatic orifice system of individual room temperature control and electrical modulation of recirculating air systems, completely meets all the varied and exacting problems of providing correct and accurate temperature control. Installation, as well as operating costs are equally low in old or new, large or small buildings. . . . There is a Minneapolis-Honeywell engineer in your city, or near it, who can show you the advantages of the Modustat System. Minneapolis-Honeywell Regulator Co., 2701 Fourth Avenue South, Minneapolis, Minnesota.

MINNEAPOLIS-HONEYWELL
Control Systems

vanometer pointer. The V-shaped drive cam then engages and rotates the roller, which in turn transmits its *straight-line motion* to the slide-wire contact, moving it a corresponding distance. The pen or print wheel, being mounted integrally with the slide-



wire contact, moves with it, to make the record coincide accurately with the measurement.

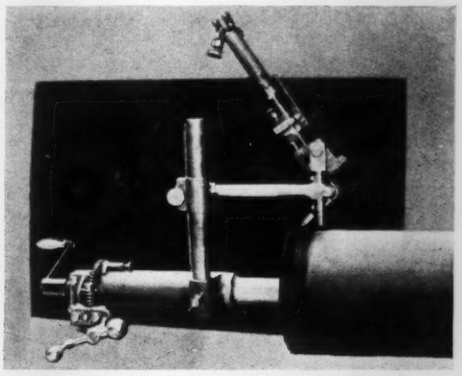
The recorder is housed in a fume-tight and dust-proof case so designed that it may be either flush—or surface—mounted. The entire mechanism can be swung forward out of the case, making every part accessible for inspection.

The connection compartment of the recorder, which is sealed from the interior of the case and is accessible from the outside, allows thermocouple and motor connections to be made or inspected without opening the main compartment containing the mechanism.

This instrument is completely described in a new 16-page bulletin.

Pipe-Cutting Machine Introduced

A new pipe-cutting and beveling machine has been announced by The Linde Air Products Company, 30 East 42nd St., New York City. It consists of a center rod with three spreading arms which press against the inner wall of the pipe, holding it in position, with an arm supporting a blow-pipe that can be adjusted



to the desired angle of the cut. The blow-pipe and arm rotate without the use of a crank for quick centering of the device, and by means of a crank when doing actual cutting.

This machine will take almost any hand-cutting blow-pipe, is readily portable, and its operation is extremely simple, according to the announcement. Once centered in the pipe, the operator

Modernization at Lincoln Life

SHOWN above is the Home of the Lincoln Life Insurance Co., Fort Wayne, Ind.—another recent Clarage installation.

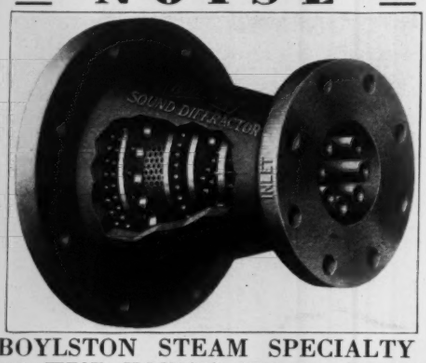
This entire building is ventilated by Clarage Fans and Air Washers with the Executive Offices on the third floor *completely* air conditioned by additional Clarage equipment. Here is an excellent example of modernization; the building erected some years ago; the Clarage apparatus installed last summer without costly alterations or great inconvenience.

Clarage engineers can give you valuable assistance whether you have a new or old building to air condition. Write us for any information required. CLARAGE FAN COMPANY, Kalamazoo, Mich. Sales Engineering Offices in All Principal Cities.

CLARAGE

AIR HANDLING AND CONDITIONING EQUIPMENT

NOISE



● This is a device for preventing NOISE made by steam passing through a pressure reducing valve. No moving parts.

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126 WEST ILLINOIS STREET, CHICAGO, ILLINOIS

TINKER-PROOF

CAST IRON MUSHROOM DOME OR FLAT TOP

Yes, NU-NOTCH now comes to you equipped with a special adjustment bolt and a locking key. No one can tinker or meddle with its desired set adjustment.

Its mushroom-shaped head cannot be loosened, rattled or taken off except by the holder of the key.

This is another Knowles improvement—the kind that has kept Knowles a leader in the air diffusing field for 23 years.

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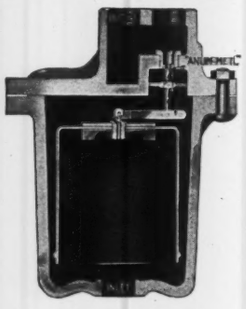

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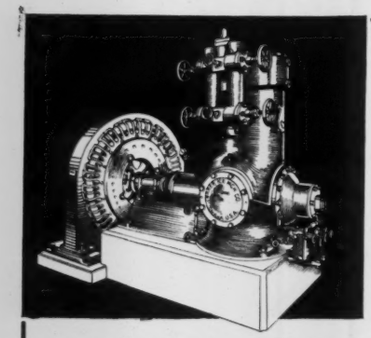

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1590 Evans St., Omaha, Neb.
Factories: Omaha, Seattle, Ft. Worth, Los Angeles

merely turns the crank causing the blow-pipe to rotate evenly around the pipe, making a clean machine-like cut. The machine is said to be a time- and money-saver wherever large quantities of pipe are to be cut and beveled.

Develops Constant-Level Oil Control

The Lunkenheimer Company, Cincinnati, Ohio, has developed a new constant-level oil control designed to maintain automatically a constant oil level in ring-oiled bearings or anti-friction bearings suitable for oil-bath lubrication, and insure against failure of oil supply and consequent costly shutdown of equipment. Waste is eliminated as it feeds only enough oil to maintain the required level, and as long as any oil shows in the glass bottle none need be added.

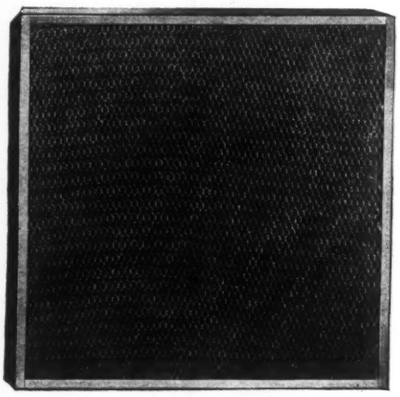
This device operates on a liquid-seal principle. It feeds only when the oil level in the bearing drops below the end of the shank, breaking the liquid seal and permitting air to enter the bottle. It will not feed as long as the oil level is at or above the beveled end of the shank. The device should be installed so that the bottom edge of the adjusting collar is in line with the proper oil level in the bearing box. The collar has a vertical adjustment range of ½ in.

To refill, the bottle with its base may be lifted out of the tee fitting without disturbing any connections. Where a number of the devices are in use, spare bottles may be filled at some central point and substituted for the empty ones.

New Coating Feature of Filter

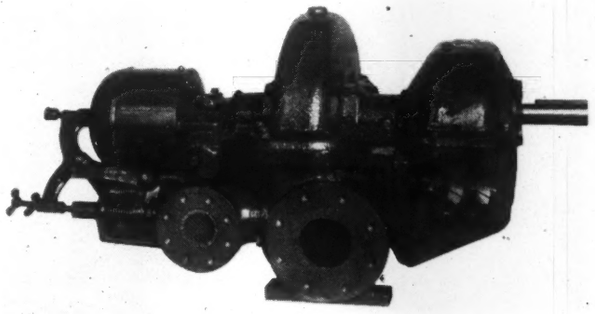
A new air filter of the rigid, self-supporting type having welded steel frames with expanded-metal sides and a fibrous filler has been developed by Russell Electric Company, 348 W. Huron St., Chicago, Ill. According to the maker, the particular feature is an odorless coating which has little change in viscosity over a wide temperature range and does not harden when cool.

Sizes of the units are 20x20x1½, 16x25x1½, and 20x30x1½. The first two have an area of 400 sq in. and show a pressure drop of 0.08 in. of water at 800 cfm, according to a data sheet which has been issued. The third has an area of 600 sq in. and shows the same pressure drop at 1200 cfm.



New Close-coupled, Turbine-gear Equipment

A new line of close-coupled, turbine-gear sets, each consisting of a steam turbine and speed-reducing gear, has been announced by the General Electric Company, Schenectady, N. Y. These equipments are designed to drive centrifugal pumps, fans, and other relatively low-speed apparatus by means of the speed-



reducing gear, the turbine operating at a relatively high, efficient speed. The sets are particularly applicable where exhaust steam can be used for heating purposes (such as in milk-drying machines). Operation is simple and inasmuch as the sets are self-lubricated, they require little attention.

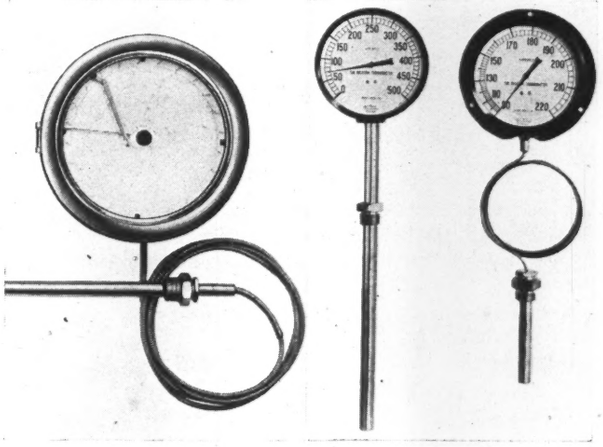
The housings of the turbine and gear are bolted together to form a single structure supported on the base of the turbine. This arrangement provides a compact unit with a minimum of bearings and assures a correct alignment of turbine and gear, says the announcement.

The turbine can be arranged to operate at steam pressures up to 400 lb, temperatures up to 750 F, and back pressures up to 40 lb gage. The speed of the low-speed shaft may be within the range of 180 to 3000 rpm. The capacity of these turbine-gear sets ranges from 10 to 150 hp.

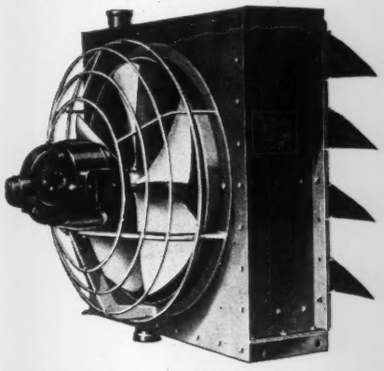
New Recording and Dial Thermometers

A new recording thermometer suitable for general industrial applications has been announced by the Jas. P. Marsh Corporation, 2073 Southport Ave., Chicago; this new instrument is made in two general types—gas-filled and vapor-tension.

The former is suitable for applications up to 1000 F (or equivalent Centigrade) temperature, and a variety of chart ranges are available for different requirements, such as oven temperatures, flue gas, steam, feed water, hot and cold water, vat temperatures, inside and outside atmospheric temperatures, etc. The vapor-tension instrument is suitable for application to steam and hot-water temperatures where the operating range is not more than 30 per cent of the total scale range. Both types can be made to



WING UTILITY UNIT HEATERS



Wing Unit Heaters Offer the Simplest Solution of Your Heating Problems

You may not have to consider a complete new heating layout but may have certain areas or departments where the heat is spotty and where your men hate to work, on cold days. If so, the installation of one or more Wing Unit Heaters will solve this problem, quickly and inexpensively.

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Wing Utility and Featherweight Unit Heaters
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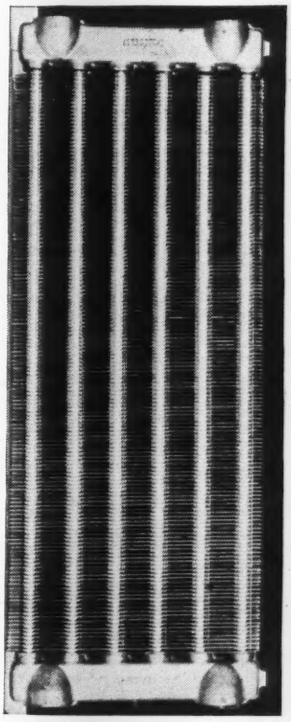

One Type of Coil Made By Bush For a Unit Air Conditioning System. If Our 32 Standard Combinations of Fin and Tube Sizes Do Not Fit Your Requirements We Are Completely Set Up To Quote On Special Coils As Shown Above.

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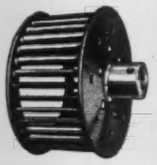

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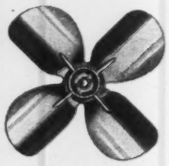
FANS AND
BLOWER WHEELS

Patented All Aluminum Multiblade, Balanced Blower Wheels. Unexcelled for quiet and smooth operation.

30 years' experience building Propeller Fans, assembled, balanced and tested, ready to mount on motor shaft.



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TORRINGTON, CONN.

No extensive changes in piping are necessary to install the B & J Proportionator System for zone heating in buildings already equipped with vapor or vacuum heat. The system is extremely simple, requires no complicated electrical devices and cuts fuel bills—in some cases as much as 40%. Write for Bulletin 123.

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DETROIT STOKER COMPANY
GENERAL MOTORS BUILDING
DETROIT, MICH.

FOR LOWER STEAM COSTS
FOR ALL OPERATING CONDITIONS
FOR ALL BOILERS
FOR ALL BITUMINOUS COALS

Ric-wiL Tile Conduit, Type F, insulated with Dry-paC.

RIC-WIL TILE CONDUIT

with Loc-liP Side Joint, is a complete Conduit System providing ample protection for underground steam and hot water pipes. Completely engineered, it eliminates extras.

DRY-PAC INSULATION

is waterproofed, thus keeping steam pipes dry and maintaining the highest thermal efficiency. Write for complete details.

Tile Ric-wiL, Type F, with three pipes.

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REG. U. S. PAT. OFF.
RIC-WIL
CONDUIT SYSTEMS FOR UNDERGROUND STEAM PIPES

special order in two- or three-pen construction; the gas-filled instrument can be made in a two-pen construction in which one pen operates on temperature and the other on pressure, where the pressure and temperature range are approximately the same. The bourdon tube principle is utilized.

New dial thermometers have also been announced by this company, in self-contained and distant-reading types. The former is constructed with the sensitive bulb fastened directly to the instrument; the other is provided with a flexible tubing, making it possible to obtain temperatures at inconvenient points. These thermometers operate on the bourdon-tube principle. The vapor-tension type is suitable for temperatures below 500 F (or equivalent Centigrade); the gas-filled type for temperatures up to 800 F (or equivalent C).

Small Light for Many Jobs

A peep-hole light valuable for searching out small parts of equipment to be repaired or inspected enables the repairman to inspect thoroughly the bearings, oil rings and small parts of motors and other equipment without disassembling. Installed at the East Pittsburgh works of the Westinghouse Electric and Manufacturing Company, this inexpensive miniature spot

light was constructed from an ordinary fountain-pen-type flashlight. It is attached to a flexible cord and arm in a convenient position over the bench and is energized with a small transformer mounted on the wall. As the ordinary extension light is rather cumbersome and cannot be used for getting into the interior parts of small apparatus this trouble light has proven itself to be a time saver and a valuable addition to the inspection bench.

When not in use the light may be placed in the receptacle at the end of the arm and swung aside until needed.

Small High-Pressure Boilers

A line of small high-pressure boilers for industrial purposes now offered by The Titusville Iron Works Company, Titusville, Pa., includes four types for mechanical firing, although two of them can be equipped with grates for hand-firing. The boilers have been developed for any use where small quantities of steam at high pressure are required, such as in cloth-pressing and finishing plants, dairies, bakeries, and the like. Conventional in design, the boilers are types that have been made in larger sizes for some years.

Two vertical types and two horizontal types are included. A small Scotch type with rotary oil burner can easily be made portable. All types can be altered to suit particularly special conditions.

Recent Trade Literature

Alloys: Republic Steel Corporation, Central Alloy Division, Massillon, Ohio. 8-page booklet on Enduro 4-6 per cent chromium steels available in all the usual forms, such as sheets, plates, hot- and cold-rolled strip, bars, etc. Much information about these corrosion- and heat-resisting alloys is given.

Compressors: Worthington Pump and Machinery Corporation, Harrison, N. J. 8-page bulletin on single horizontal—single stage steam- and motor-driven gas and air compressors with feather valves and tapered roller bearings, giving complete information on construction, dimensions, and specifications. Also two bulletins on portable compressors.

Cooling Towers: The Marley Company, Kansas City, Mo. 16-page bulletin devoted to forced-draft spray cooling towers, illustrating their use in connection with several air-conditioning plants, and describing constructional features. Nozzles, fans, and drift eliminators are described in detail. A section is devoted to small mechanical-draft towers.

Fuel Saving: The Brown Instrument Company, Wayne and Roberts Avenues, Philadelphia, Pa. Folder describing how records of per cent CO_2 as a firing guide make substantial savings possible. Features of electric CO_2 meters are briefly described.

Meters: Worthington-Gamon Meter Company, Harrison, N. J. Data sheet on beer meters, giving features, specifications and list prices.

Oil Burners: S. T. Johnson Co., 940 Arlington Ave., Oakland, Calif. 16-page booklet on rotary-type oil burners, including sizes and ratings, dimensions and construction, semi-automatic controls, air and oil control, fuel-oil pump, fuel-oil preheater, and general information about advantages of oil heating.

Pressure Instruments: The Foxboro Company, Foxboro, Mass. 40-page catalog of recording, controlling and indicating pressure instruments, describing constructional features in detail, and including sections on charts, gage boards, accessories, etc. Many types of gages are illustrated and their features discussed.

Pressure-Regulating Valves, Pump Governors, Strainers: The Strong, Carlisle & Hammond Company, 1392 W. Third St., Cleveland, Ohio. 8-page bulletin describing several types of pressure regulators, two types of pump governors, and quick-cleaning strainers. Information on determining the correct size of pressure regulators (including two helpful tables) is included.

Refrigeration Compressors: Worthington Pump and Machinery Corporation, Harrison, N. J. 6-page bulletin on vertical duplex type refrigeration compressors, 5 in. by 5 in. and smaller, and a similar bulletin on sizes 6 in. by 6 in. and larger. Details are described and illustrated and specifications are given.

Refrigeration: Baker Ice Machine Co., Omaha, Neb. 6-page bulletin on refrigeration for breweries. Also a 4-page bulletin on refrigeration for food stores. The equipment and its features are described; applications are discussed.

Screws, Bolts, Nuts: Pheoll Manufacturing Company, 5700 Roosevelt Road, Chicago, Illinois. Catalog giving complete information on screws, bolts, nuts, and allied products, including standard items and special products. A number of reference tables and other helpful data are included.

Stokers: Detroit Stoker Company, General Motors Building, Detroit, Mich. 32-page bulletin on single-retort stokers, side-cleaning, plunger-feed mechanically driven to motor, steam turbine or steam engine, with various arrangements of auxiliaries and application to wide range of boiler types and sizes. Also, 16-page bulletin on stokers for small power boilers (particularly suited to low set units) with illustrations of design and applications.

Welding: The Hobart Brothers Co., Troy, Ohio. 12-page booklet discussing arc-welding copper to copper and copper to steel, containing detailed instructions for applying a new method.

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8 cents for each word including heading and address. Count nine words for keyed address. Minimum $2.00 for each insertion. One inch $4.00. Cash must accompany order. Copy must be in our hands by the twenty-fifth of the month previous to issue.

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AIR CONDITIONING ENGINEER

Air Conditioning Engineer, M.E., ten years' experience designing and testing of units and compressors. Address Key 221-A, "Heating, Piping and Air Conditioning," 1900 Prairie Avenue, Chicago, Illinois.

AIR CONDITIONING EXECUTIVE seeking connection offers benefits of college education, sixteen years' experience and responsibility covering technical problems of design and application, specifications and contracts, planning and securing sales, training and guiding salesmen and branch office management. Also major fan company training covering every phase of air work. Address Key 215-A, "Heating, Piping and Air Conditioning," 1900 Prairie Ave., Chicago.

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CAPABLE ENGINEER

wishes to represent manufacturer of regulators and valve specialties. Western New York and Pennsylvania territory. Address Key 222-A, "Heating, Piping and Air Conditioning," 1900 Prairie Avenue, Chicago, Illinois.

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In the Air Conditioning System

of the new Christian Science Publishing Society Building

rustless EVERDUR

for humidifiers

IMPOSING in appearance and soundly constructed throughout, the new Christian Science Publishing Society building in Boston was designed to require a minimum of upkeep expense. More than 1,000,000 pounds of rustless Anaconda Metals were used in its construction.

Made possible by contributions of Christian Scientists the world over and constructed of quality materials throughout, the Christian Science Publishing Society building will be one of Boston's outstanding structures for many, many years.

For hot and cold water supply lines, as well as for steam lines, Anaconda "85" Red-Brass Pipe was used throughout.

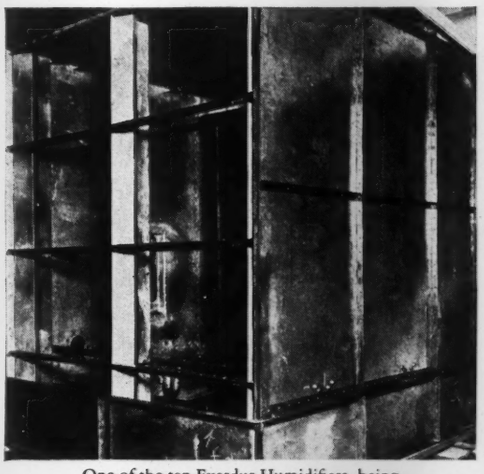
In the air conditioning system, the ten large humidifying units were made of Everdur. This exclusive Anaconda Metal consists largely of copper, with silicon and manganese added to improve physical properties. It offers excellent resistance to most corroding agents. Because it also possesses the strength of mild steel, and is readily welded by usual methods, Everdur has proved ideal for manifold uses where corrosion resistance is a factor of importance.

THE AMERICAN BRASS COMPANY
General Offices: Waterbury, Connecticut
Offices and Agencies in Principal Cities
In Canada: ANACONDA AMERICAN BRASS LTD., New Toronto, Ontario

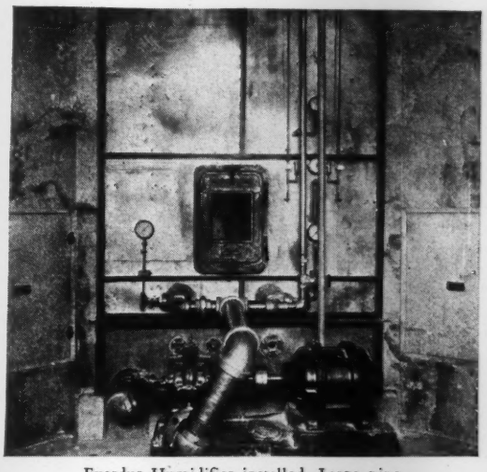
ANACONDA from mine to consumer

See our Exhibit in Space No. 45
Third International Heating & Ventilating Exposition, Grand Central Palace, New York
February 5th to 9th, 1934

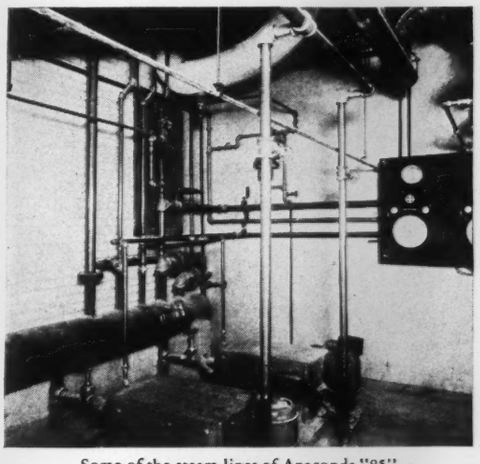
NRA



One of the ten Everdur Humidifiers, being assembled in the plant of Buffalo Forge Co.



Everdur Humidifier installed. Large pipe in foreground is Anaconda "85" Red-Brass.



Some of the steam lines of Anaconda "85" Red-Brass Pipe.

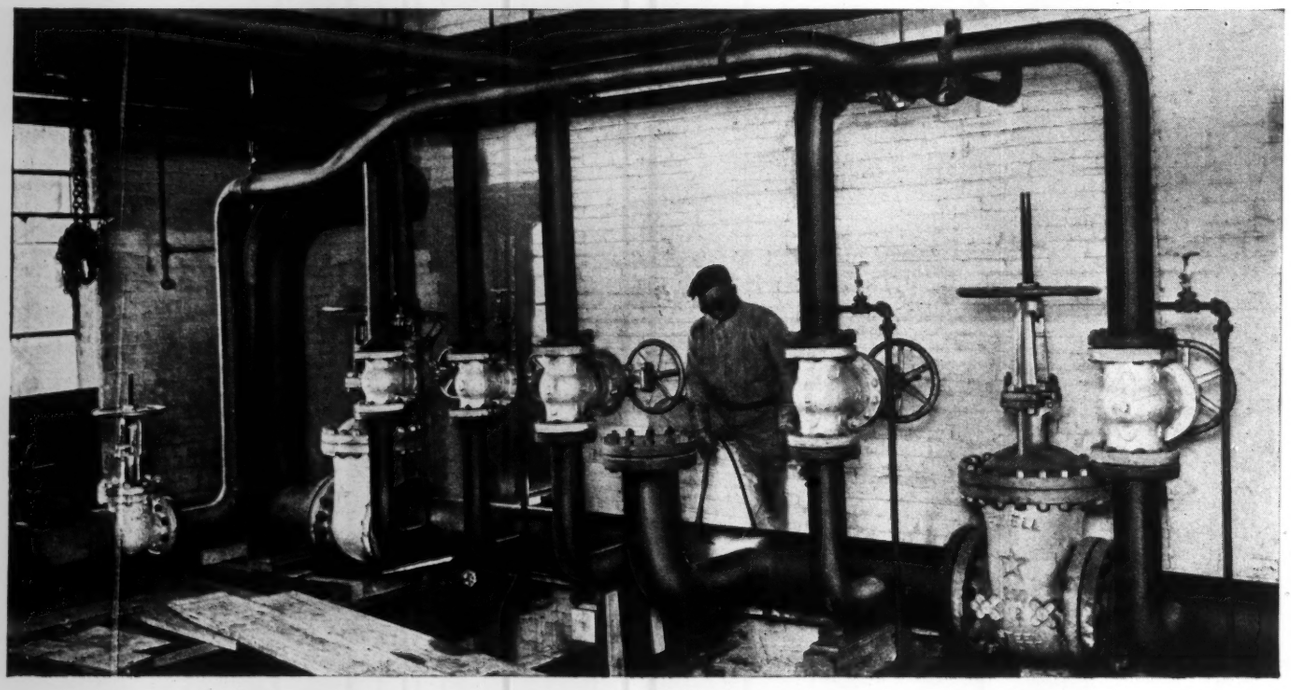
Chester Lindsay Churchill, *Architect.*—Aberthaw & Co., *General Contractors*—Lockwood Green Engineers, Inc., *Consulting Engineers*—Carrier Engineering Co., *Air Conditioning Contractor*—Ralph & W. B. Johnson, *Plumbing Contractor*—James S. Cassidy, Inc., *Heating Contractor*

Tanks of EVERDUR [STRENGTHENED COPPER] EVERDUR

AN ANACONDA METAL · MADE SOLELY BY THE AMERICAN BRASS COMPANY

EVERY TURN A TUBE-TURN!

BELOW you see a part of one of the prettiest pipe-welding jobs in the country—the new steam header in the power plant of the U.S. Playing Card Co., Cincinnati. Needless to say, almost every direction-change on the job is made with Tube-Turns, the original fittings for pipe-welding—the fittings that are *drawn* (not bent) from seamless steel tubing. • Let us repeat: Tube-Turns are not bends. They are 45 degree and 90 degree elbows (and 180 degree returns) for welding, made from seamless pipe by an entirely exclusive process. This process produces full, uniform wall-thickness *at all points.* There is positively no thinning or stretching of the back walls—no thickening, buckling or compressing of the inside walls. Wall-thicknesses *always* within A.S.T.M. specifications. Therein lies their unique advantages in strength, in resistance to corrosion, in long life. • If you are in doubt as to what welding fittings are best from the standpoint of strength, free flow, corrosion-resistance, economy of installation and maintenance, write for all the facts about Tube-Turns. No obligation, of course. Address: Tube-Turns, Incorporated, 401 Herald-Post Bldg., Louisville, Ky. • *Below:* 4″, 6″, 8″, 10″ and 12″ Tube-Turns in the 12″ all-welded main steam header (200-lb. S.S.P. at 100° super-heat) in U.S. Playing Card Co. power plant, Cincinnati. Mensing Co., Philadelphia, *Consulting Engineers;* A.G. Ruff, *Erection Engineer.* J.J. Braun, *Gen'l Supt.* The handsome gentleman with the torch is Patric Gallo.

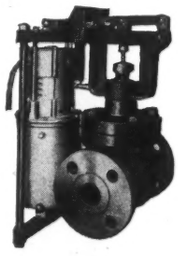


Note the trim, pleasing appearance of this new valve. The hex-nut below the convenient conduit outlet provides 50% regulation — an important factor in adjusting the flow of water in air-conditioning devices

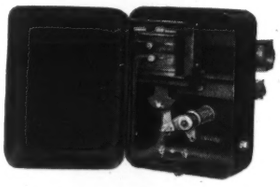
NEW Electrically Operated Valve

Small . . . . . Compact. . . . . Inexpensive

Ideal for Air-Conditioning Needs



The Thrustor valve is recommended for heavy-duty service. Its velvet-smooth action assures long life. Write for bulletin GEA-1569



Solenoid-operated valve for pressures up to 250 lb. and temperatures to 700 deg. F. Write for bulletin GEA-1423

WHEREVER you need a small valve to handle fluids quickly, easily, and economically by remote control, use this new G-E solenoid valve. It has these and other important advantages:

1. **Only 4 1/2 inches high, 2 1/4 inches in diameter — weighs less than two pounds**
2. **Valve parts "sealed in steel"**
3. **Low maintenance — no stuffing box**
4. **Economical — uses only 7 1/2 watts at 110 volts, 60 cycles**
5. **Built-in terminal box simplifies installation**
6. **Positive action — accelerated core assures quick, positive opening and closing**
7. **50% regulation with convenient metering pin**
8. **Pleasing appearance — valve is housed in lustrous nickel-plated case**

In addition to this new midget valve, General Electric has a complete line of solenoid and Thrustor valves. They are available for a wide range of temperatures, pressures, pipe sizes, and fluids. For complete information, write to the nearest G-E office, or General Electric, Dept. 6B-201 Schenectady, N. Y.

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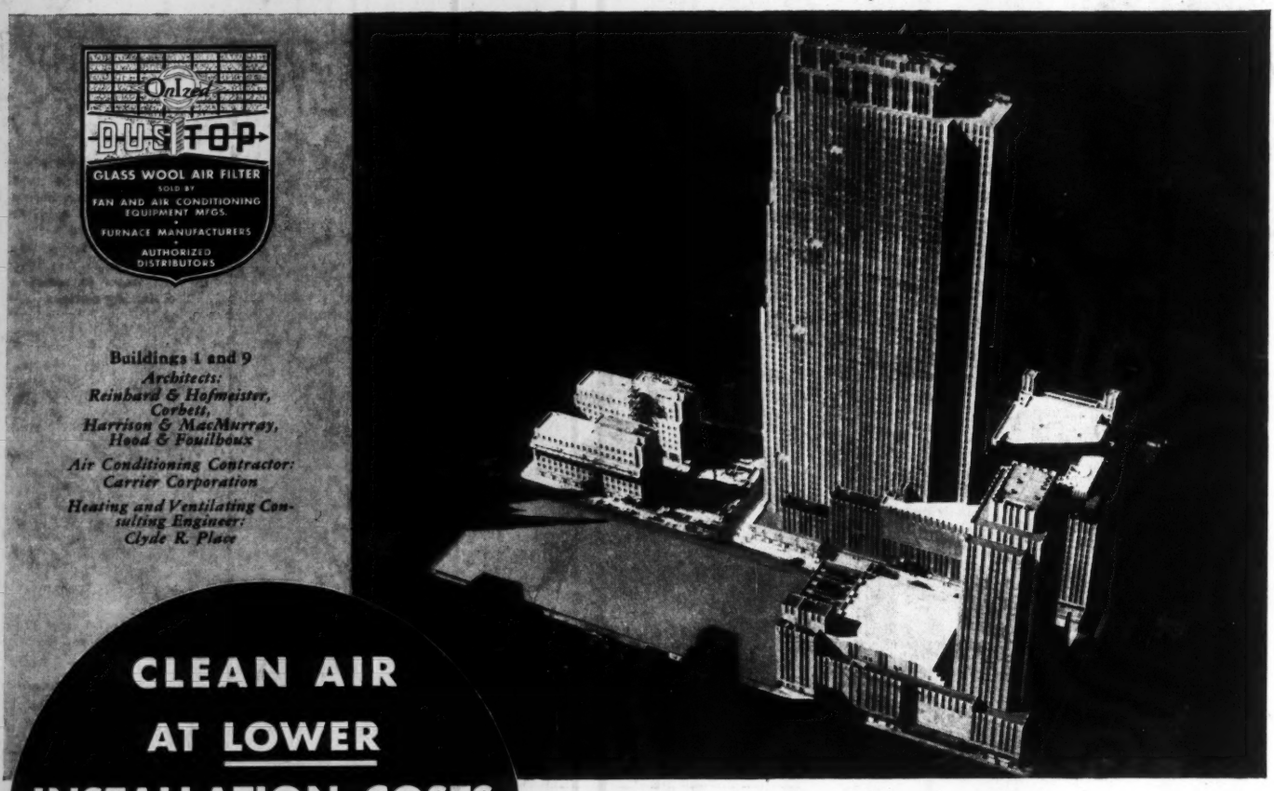

Air handled—277,600 C. F. M.
Initial cost of Dustop filters—$2425.00 complete
Monthly operating cost—$65.00 (Based on 3 changes per year)

CLEAN AIR AT LOWER INSTALLATION COSTS AND LOWER OPERATION COSTS

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● Impressive is the air filtering system installed in Radio City's largest building No. 9. Dustop is designed for large and small industrial and building use where air is mechanically handled.

Dustop filters are installed in frames in tandem and, when loaded, are removed and discarded, being replaced with fresh units. No cleaning required. Write for full information and catalog A. I. A. 30-d-3. Owens-Illinois Glass Company, Industrial Materials Division, Toledo, Ohio. (Dustop is assembled and installed in Canada by General Steel Wares, Ltd., Toronto.)

OWENS-ILLINOIS

DUSTOP AIR FILTERS